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Naming the Comet

CIRCULAR No. 1616 of the International Astronomical Union was issued on August 28th by the Central Bureau for Astronomical Telegrams, Copenhagen Observatory, Denmark. In it Dr. Julie M. Vinter Hansen discusses the problem of naming Comet 1957d:

"At the discovery of a bright new comet many professional and nonprofessional discoverers come forward to put in a claim for having their name attached to the comet. Such has also happened in the case of comet 1957d, and the Central Bureau of Astronomical Telegrams in Copenhagen has received several of these claims. According to information submitted to us the first to have seen the comet seems to have been Mr. *Sukehiro Kuragano* of Yokohama, who through Mr. *Sigeru Kanda* sent a very rough observation of 1957 July 29, 19^h U.T. Mr. Kanda's letter, however, was not dispatched from Japan until Aug. 13. The second person to have seen the comet is the American Airlines pilot *Peter Cherbak,* who saw it in the morning of July 31, while flying between Denver and Omaha. Mr. Cherbak very considerately did not immediately report his discovery, as he wanted to confirm it so as not to alert falsely the astronomical world. This confirmation took place on the morning of Aug. 1, and he then informed the Griffith Planetarium of his discovery. Not until August 4 was a telegram sent (from the Mount Wilson and Palomar Observatories) to the Harvard Observatory. By then, on August 2, a telegram from *Mrkos* of Czechoslovakia had reached the Central Bureau in Copenhagen announcing his discovery of the comet in the morning of August 2 and giving an approximate position. Naturally the Bureau attached the name of Mrkos to the comet it being the first notification we had had of this comet. Before our telegram of August 3 about the new comet reached England a young man, *Clive Hare,* at 2^h 50^m that same day had discovered the comet and duly notified the Royal Greenwich Observatory. Several other communications about independent discoveries of this bright comet have been received at various observatories and at the Central Bureau but for practical reasons we should not deem it advisable to attach a string of names to the comet, but rather keep on using the designation Comet Mrkos (1957d)."

The unheralded advent of this major comet, only four months after widely observed Comet Arend-Roland, attracted much attention from amateur astronomers throughout the Northern Hemisphere. Starting on the next page of this issue is a selection of photographs of Comet Mrkos; on page 606 are orbital data and charts of the comet's motion.

Alan McClure, the Los Angeles amateur whose picture of Comet Arend-Roland was printed on the cover of the June issue, first photographed Comet Mrkos on August 8th. But he could not avoid interference from moonlight until the 13th, when this 13-minute exposure was made at 8:10 p.m. Pacific standard time. His earlier observing site in the mountains near Mt. Wilson was abandoned because of smoke from local forest fires, and he moved to Frazier Mountain, 65 miles northwest of Los Angeles, observing from 8,000 feet above sea level. The greatest length of the main tail measurable directly on the plate is 12½ degrees, and the extreme length of the secondary (straight) tail from the head of the comet 9½ degrees. The reproduction scale is 1¼ degrees per inch. The camera had a 4-inch Goto f/5 lens, and the emulsion was Eastman 103a-E. Some later pictures by Mr. McClure are reproduced on pages 570 and 571.

Comet 1957d — an Unexpected Visitor

THE FOURTH comet discovery of this year, Comet 1957d, was of the 1st magnitude when it appeared close to the sun in the morning sky at the beginning of August. The Czech astronomer Antonin Mrkos sighted the comet on the morning of August 2nd and promptly wired Copenhagen Observatory, which announced the new object to the world as Comet Mrkos. A brief account of the discovery of this comet was published in *Sky and Telescope* just as the September issue went to press, on page 528.

But the bright visitor was its own best herald, for hundreds of observers detected it independently in the next few weeks. Interest was especially keen because 1957d soon became visible in about the same part of the evening sky as Comet Arend-Roland, which was the first naked-eye comet of the year and had been prominent only a few months earlier. This was a coincidence; the two bodies are unrelated.

Thus, with two fine comets to its credit, 1957 marks an end to a long interval in which there were no easily observed objects. Comets 1947n and 1948l were briefly seen in mid-northern latitudes, but Comet Mrkos was the most conspicuous of all of them.

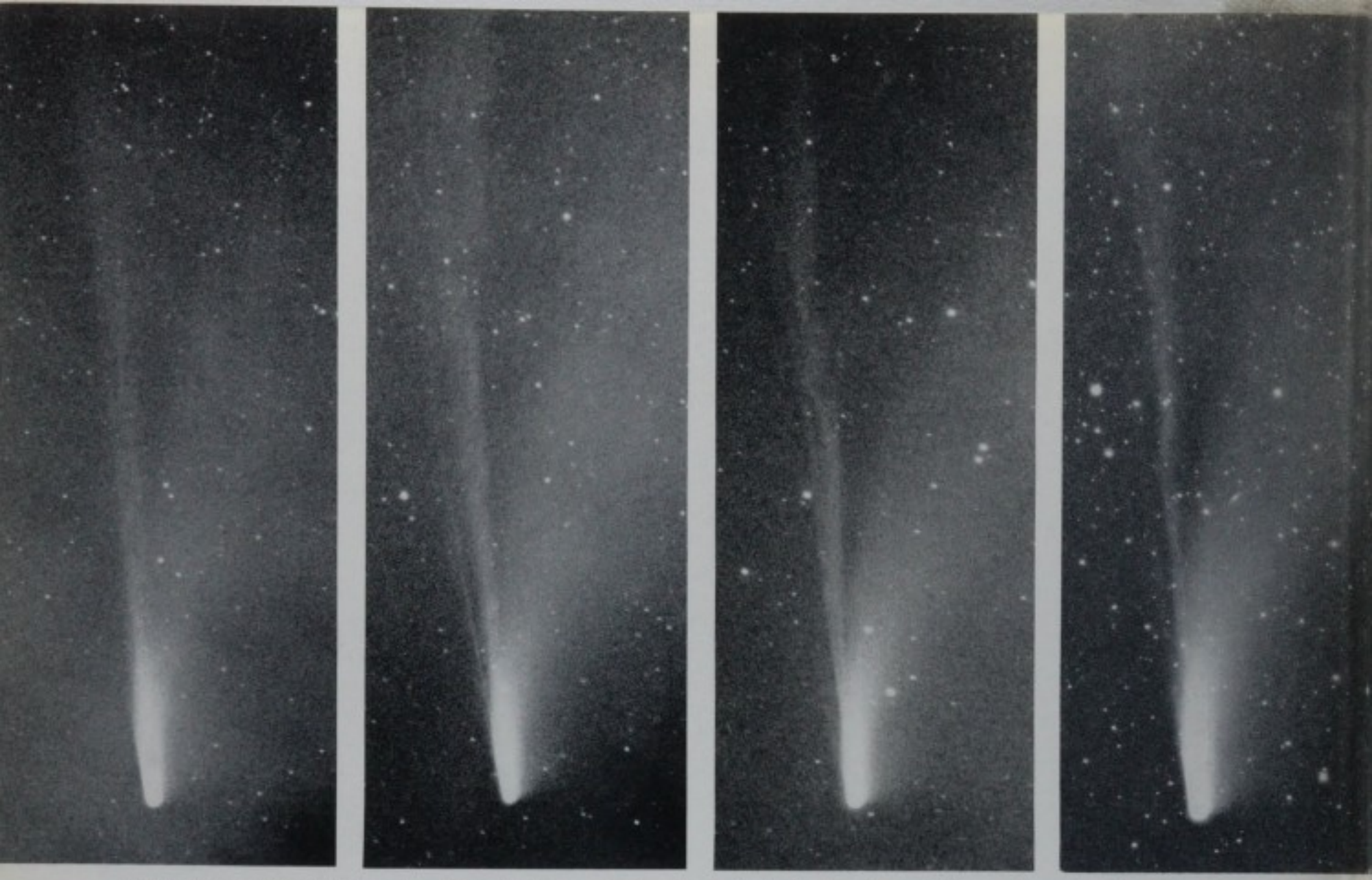
Curtis A. Griffin, Concord, California, took this one-minute exposure at 8:30 p.m. Pacific standard time on August 13th. He used Tri-X film, a 120 reflex camera with an f/3.5 lens, and the enlargement is about five times. Even on this small scale, some of the features in the picture opposite, taken about 20 minutes earlier, may be seen.

Airline pilot Peter Cherbak had seen the comet on July 31st, at about 4:00 a.m. Mountain standard time, while flying over North Platte, Nebraska, at a height of about 20,000 feet. This seems to have been the first comet discovery ever made from an airplane. He viewed it again the morning of August 1st, about five degrees east of the star Castor, in Gemini. Later that day, Mr. Cherbak telephoned his finding to the Griffith Observatory in Los Angeles, but bad weather prevented any check at California observatories until August 4th, when the Cherbak observations were telegraphed to Harvard and first became generally known.

An even earlier observation had been made at Yokohama, Japan, on July 29th, by Sukehiro Kuragano, but his discovery

At Sacramento Junior College Observatory, Victor W. Killick found a large crowd gathered on the evening of August 9th, the day after the comet was first sighted there. On August 10th, at an organized public night conducted with the aid of the Sacramento Valley Astronomical Society, this picture was taken by Robert Gliebe. Julian Felkey helps a young observer to look through a 3½-inch refractor, while others await their turns.

An early photograph of the bright inner parts of Comet Mrkos, made at 8:00 p.m. PST, August 8th. Roger Lynds used the 20-inch reflector at Leuschner Observatory, on the Berkeley campus of the University of California. The telescope's field of view was partially obscured by trees.



The comet's straight tail underwent rapid changes during the week beginning August 16th, as shown in this seven-picture series by Paul H. Preo, Rochester, New York, and by Alan McClure, Los Angeles, California. Mr. Preo used a 3.6-inch f/3.5 Aero Xenar lens, guided with a 3¼-inch refractor. Left to right, he took the first three pictures on: Aug. 16, 8:30-8:45 p.m. Eastern standard time; Aug. 17, 8:35-8:55; Aug. 18, 8:35-9:00; and the sixth, Aug. 21, 8:40-9:00.

On August 19th, from 8:50 to 9:35 p.m. Central standard time, Joseph H. Senne photographed Comet Mrkos at Ames, Iowa, using a small f/3.7 Ektar lens and Eastman Tri-X film. The camera was mounted on a 3-inch equatorial refractor, which was used for guiding. Note the bright meteor that crossed the bottom of the field.

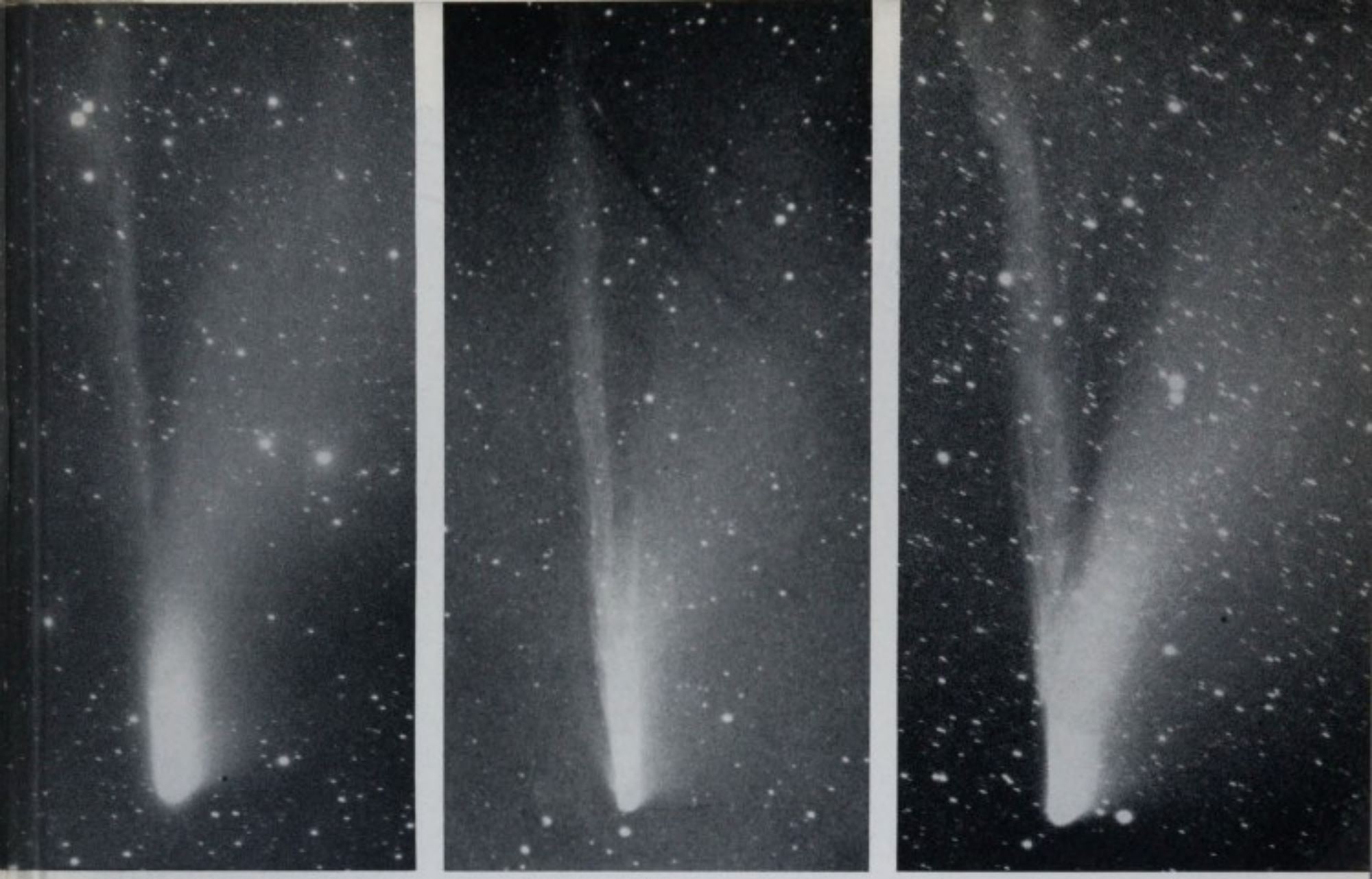
was also announced late. With so many independent discoverers, there was considerable uncertainty as to the name by which the comet would be known. This has been cleared up by the announcement in International Astronomical Union *Circular* No. 1616, quoted on page 567, and the name will be simply Comet Mrkos.

Many readers were puzzled by the sudden appearance of the new comet, without any advance prediction, in contrast to the case of Comet Arend-Roland, for which the path until July 1st was published in our March issue (page 244). But the latter object had been discovered in the previous November, while still far from the sun. As it moved inward toward perihelion passage on April 8th, astronomers could trace its path precisely and also foretell that it would be a bright naked-eye object when it was nearest to the sun in April. They could predict that it would be visible in the northwestern evening sky, and observers everywhere were waiting to pick up the comet.

On the other hand, Comet Mrkos' orbit had an entirely different orientation in space (see diagram on page 606). As viewed from the earth during its approach, the comet was nearly in line with the sun in the sky and was masked by the solar glare. Only about the beginning of August, as it was passing perihelion, did Comet Mrkos appear sufficiently far from the sun to be seen, with difficulty. But as shown by its path among the stars, charted on page 606, quick northward and eastward motion carried it through the constellations of Lynx and Leo Minor to a conspicuous place in the northwestern sky.

On the early morning of August 3rd, the comet was independently found by a 15-year-old schoolboy, Clive C. Hare, in Tamworth, England, who reported it to be as bright as Pollux. In the United States, early independent discoverers included Owen and Russell Mattson, St. Paul, Minnesota, shortly after sunset on the 5th, and Kurt G. Brown, Erieville, New York, on the same date. Later findings are too numerous to list here.

In the four weeks following Mr. Cherbak's initial sighting, Harvard Observatory alone received telegrams, letters, and phone calls from 48 persons reporting the object as new. There is space only to



For his photographs, Mr. McClure used a 4-inch Goto f/5 lens, on a clock-driven mounting. In this week-long series, he took the fourth, fifth, and seventh pictures: Aug. 19, 11:49-11:58 p.m. Eastern standard time; Aug. 20, 11:16-11:41; and Aug. 22, 11:31-12:10. Although the three pictures on this page are wider than those opposite, the entire series has about the same scale of 1.4 degrees per inch. The comet's motion was mainly eastward (to the left).

summarize the many detailed observing reports sent to *Sky and Telescope* and to publish some of the excellent photographs made by amateur observers everywhere.

Like its predecessor, Comet Arend-Roland, the new Comet Mrkos proved unusually interesting for photographers. During the first week of August, it appears to have had a single tail, broad and strongly curved. Alan McClure's photographs from high on Frazier Mountain, 65 miles northwest of Los Angeles, show that the length of this tail steadily increased from two degrees on August 8th to 12½ degrees on the 13th.

Mr. McClure's first record of a second tail was on August 10th, as a much fainter, very straight and narrow streamer pointing away from the sun. This second tail brightened on succeeding nights, becoming traceable to a length of 9½ degrees by the 13th, when Mr. McClure took the picture on page 568. This shows remarkable bright streaks across the main curved tail, forming parts of a fan seemingly centered on the sun. These also show on the picture taken the next evening by John Farrell, of Ft. Worth, Texas, reproduced on page 572.

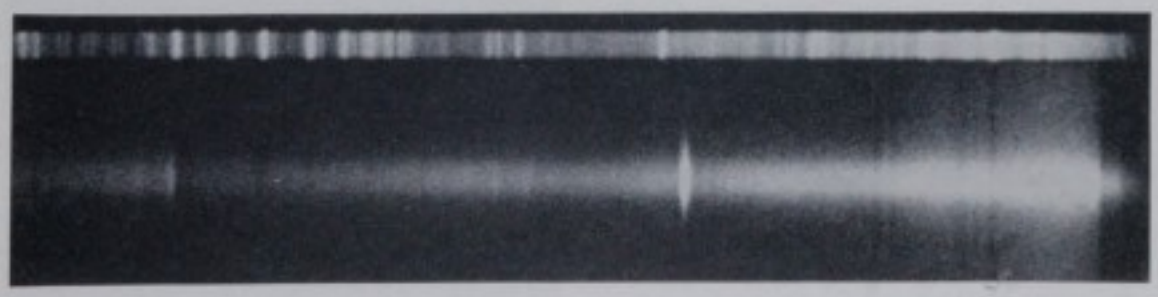
Later pictures of good quality fail to show the streaks. Was this temporary disturbance of the comet due to a burst of corpuscular radiation from the sun, which this summer was in an unusually active state?

Another spectacular change in Comet 1957d is recorded in the sequence of pictures across the tops of these pages. Note the night-to-night alterations in the narrow, straight tail. On August 16th, in Paul H. Preo's first picture, it seems a long bundle of nearly straight rays, but its structure is indistinct. Next evening this appearance is plainer, and the end of the tail is broadened and kinked; there is one very long, bright linear ray at the south (left) edge of the bundle. By the 18th, the once-straight tail is conspicuously twisted and tattered, reminiscent of the famous Comet Morehouse of 1908. On the 19th, in Mr. McClure's picture, the tail is similarly distorted. Although this feature is again straight in the next picture, it appears almost separated from the comet's head, and gradually widens outward. On the 21st, there are two kinks farther out along the tail.

It was not feasible to reproduce the uppermost part of Mr. McClure's picture of the 22nd, when both he and Mr. Preo recorded a broadening and sharp turning far out along the straight tail, where it divided into two widely separated but nearly parallel branches. Another picture of this date, made at Lowell Observatory by Henry L. Giclas but received too late

At Rocky Point on Long Island, New York, R. E. Franklin photographed the comet on August 23rd, when it was located in Coma Berenices, from 8:20 to 8:50 p.m. Eastern standard time. The film was Super-XX, and he used an Ilex Paragon lens, 12-inch focus.

This photograph of Comet 1957d was made on August 14th at 8:45 p.m. Central standard time, by John Farrell at Ft. Worth, Texas. Compare it with that by Alan McClure on page 568, which was taken about a day earlier. Mr. Farrell used a 7.5-inch f/1.5 Schmidt camera. The exposure time was five minutes on Royal Pan film.



Comet 1957d was unusual in having sodium emission lines in its spectrum. At the University of Michigan Observatory in Ann Arbor, on August 6th, the 37-inch reflector was used by Theodore Stecher to obtain this spectrogram on Eastman 103a-F emulsion, 10-minute exposure. The golden yellow color of the bright nuclear region of the comet is explained by the prominence of the unresolved double line of sodium (the Fraunhofer D line) just to the right of center; sodium gas in the comet's head was emitting this light. Emission from other gases is shown by the carbon-molecule (C_2) bands in the left-hand half of the spectrum, and by emission from the NH_2 molecule (ammonia) at the right, where the continuous spectrum of sunlight reflected from dust particles in the comet is also strong. The spectrum running along the top of the picture is from a laboratory light source, to provide a wave-length scale. University of Michigan Observatory photograph.

for inclusion in the series, shows the long tail to be very wavy and filamentary, with a remarkable third tail on the left side of the head (opposite to that of the original main tail).

This third tail, which shows faintly on R. E. Franklin's photograph of the 23rd, is broad and curved. On the Giclas and the McClure pictures of later dates, however, it is practically absent; it was a very transitory feature. During this week of violent change, there were also variations in the relative brightnesses of the straight and curved tails. A Lowell Observatory photograph of August 28th shows the straight tail about twice as long as the curved one, with the former being bent and twisted, broadening out at great distances from the comet's head.

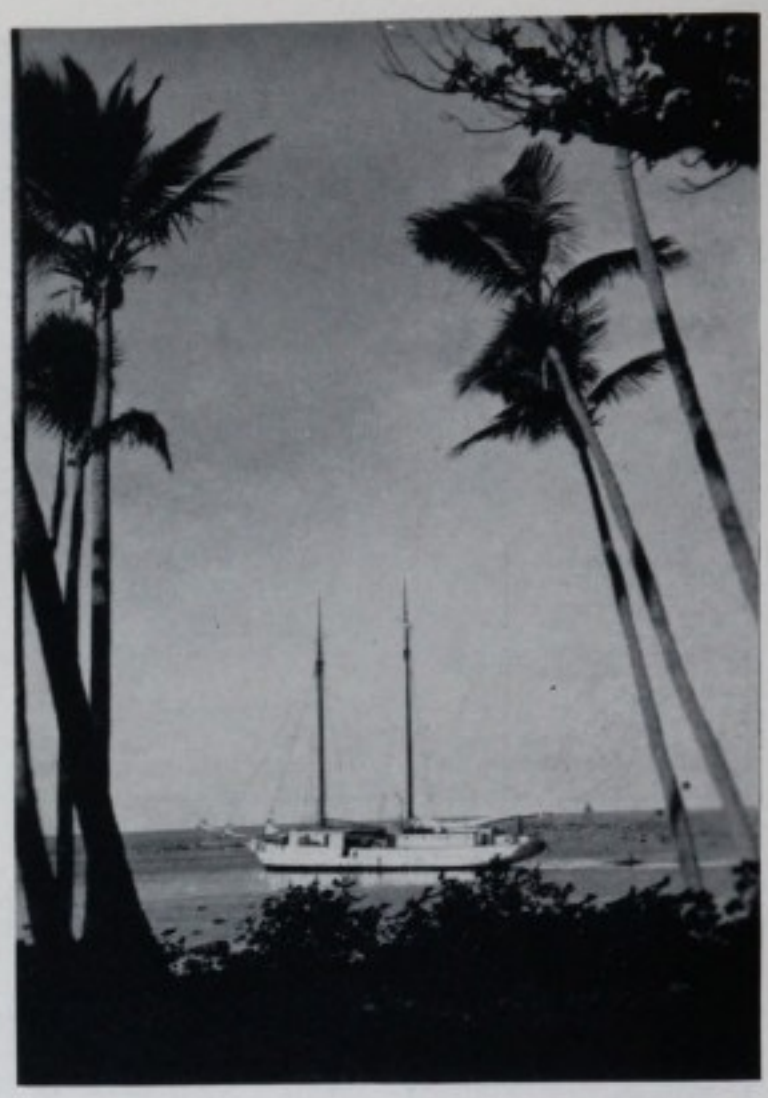
Many observers have commented that

(*Continued on page 580*)

Eclipse Islands of the South Pacific

FRANK M. BATESON

Royal New Zealand Astronomical Society



Typical of the auxiliary schooners that trade in the Pacific islands is the "Tiare Taporo," which has its home port in Tahiti. Vessels of this kind are available on charter for eclipse expeditions to the islands in the path of totality.

ONE YEAR from now, on October 12, 1958, there will be a total eclipse of the sun that may be favorably observed from only a few islands in the South Pacific Ocean. One year ago, in the October, 1956, issue of this magazine, page 538, Dr. H. von Klüber, Cambridge University Observatory, gave the circumstances of this eclipse, listed the islands in the path, and touched upon problems of reaching and observing from each of the possible sites.

The present writer is not an expert on eclipse matters or, for that matter, on the sun. My interests have always been with night skies, particularly in variable stars. As I have lived in the South Pacific for many years, however, I can supplement Dr. von Klüber's article with some further information that may aid both amateur and professional astronomers contemplating expeditions to this eclipse.

While the atolls from which the eclipse is total appear to be very isolated, they are not quite as far from the beaten track as is generally supposed. They fall naturally in three groups (see map on next page), 1, 2, 3 for the Tokelaus or Union Group; 4, 5, 6 for the northern Cook Islands; and 7, 8 for the Leeward Group of the Society Islands. The first two groups are dependencies of New Zealand, while the Society Islands are French.

Union Group. The main port of entry is at Apia, on the island of Upolu, western Samoa. It lies on the "coral route" flown by TEAL (Tasman Empire Airways Limited) from the Fiji Islands some 10 degrees of longitude farther west. Also touching at Papeete on Tahiti, this air service is run approximately fortnightly for most of the year, but is weekly when traffic warrants.

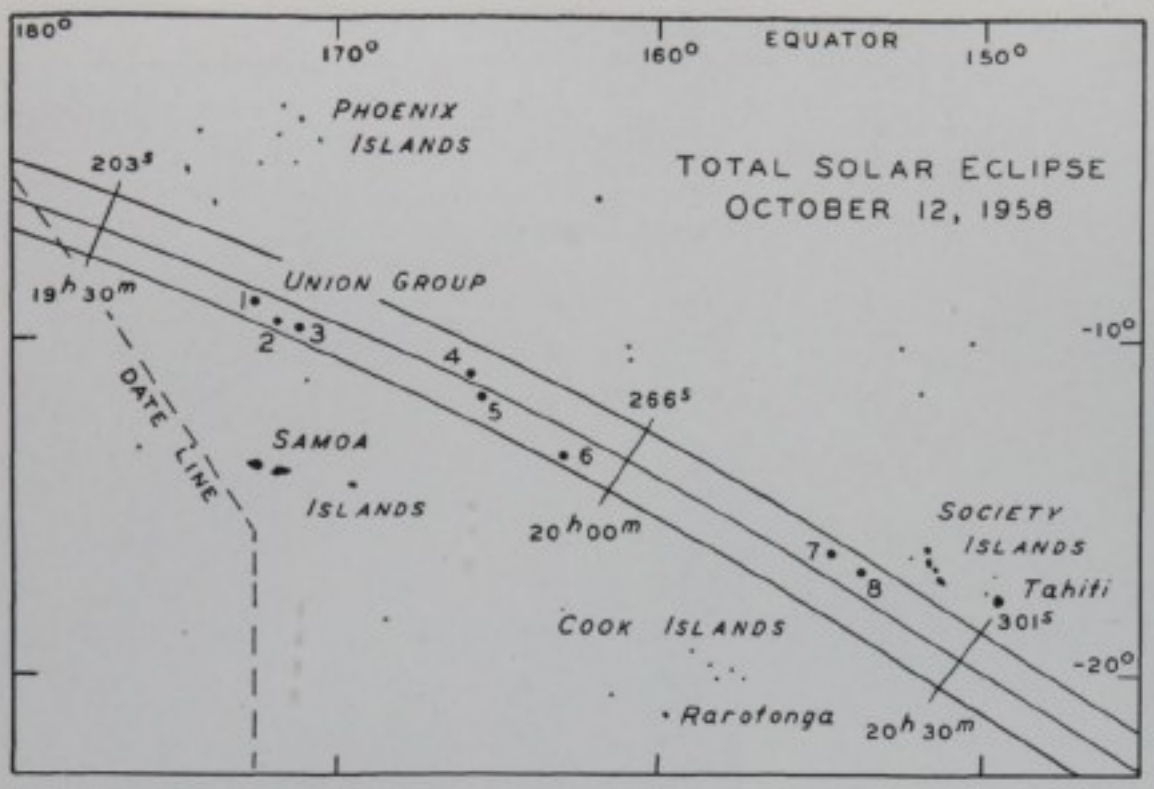
Apia can be reached from New Zealand by ships of the Union Line. Some of the same line's trans-Pacific freighters call at Apia northbound from Sydney to the Pacific Coast of North America, but such calls are irregular and usually no stop is made southbound. Irregular sailings of the General Steamship Company's freighters, such as the *Thor Isle*, are made from the United States.

Atafu, Nukunono, and Fakaofo are the eclipse islands in the Union Group. They are served generally by one vessel only, which makes calls every quarter. They do have the advantage over the other groups that it is possible for certain flying boats to land on their lagoons. But surface access to these three islands is only by means of canoes across open reefs, a procedure that sometimes is hazardous.

The island of Nassau, one of the northern Cooks that lie in the path of totality on October 12, 1958, has a rather difficult close inshore and has no lagoon worthy of the name. Totality here will last about four minutes. All photographs with this article have been provided by the author.

Northern Cook Islands. The main port of entry is at Rarotonga, where I have my observatory, with an old but excellent 8-inch Grubb refractor. Air travelers on the TEAL "coral route" disembark at Aitutaki, some 140 miles north of Rarotonga, and then have to rely on inter-island shipping to get here. We have a passenger service from Auckland, New Zealand, maintained by the small and inadequate motor vessel *Maui Pomare* which, of course, also carries cargo. Its calls are supplemented by freighters of the Union Line at irregular intervals both from and to the Pacific Coast.

The individual Cook Islands are very well served by a number of small trading vessels. Three ships are reasonably comfortable by island standards, each accommodating 14 cabin passengers and carrying about 100 tons of cargo. At least one



This chart shows the duration in seconds along the path of totality, with the Universal times of mid-eclipse. The eight coral atolls within the path are labeled with their numbers in the table below, which was prepared by H. von Kluber. Both chart and table are republished from this magazine for October, 1956, as that issue is out of print.

	Island	*Longitude (west)*	*Latitude (south)*	*Local time of totality*	*Altitude of sun*	*Duration of totality*	*Distance**	*Width of path*
1.	Atafu	172° 30′	8° 33′	8:07 a.m.	37°	204 sec.	−38 km.	195 km.
2.	Nukunono	171 53	9 10	8:10	37	142	−74	195
3.	Fakaofo	171 15	9 23	8:14	37	153	−70	195
4.	Danger Islands	165 50	10 55	8:46	45	242	+18	200
5.	Nassau Island	165 25	11 33	8:48	46	240	−24	200
6.	Suwarrow	163 3	13 15	9:04	50	164	−77	200
7.	Scilly	154 32	16 29	9:59	62	232	+60	210
8.	Mopélia	153 55	16 48	10:03	63	230	+63	210

* Distance from the central line, positive if the island is north of the line.

The data in this table are from Dr. von Klüber; they should be regarded as provisional.

owner has already indicated to the writer that he would be prepared to arrange his schedule to make a visit to the northern Cooks three or four weeks in advance of the eclipse. After dropping parties on the eclipse islands, the vessel would engage in its normal trading activities and would return to pick up the astronomers a few days after the eclipse.

For this service current fares would apply. These depend on the route taken on the northbound voyage, but from Rarotonga the round trip would be approximately $123 per person. Freight rates on equipment and supplies would be $24 per ton measurement. It might be necessary to add a charge for deviating to pick up the expeditions after the eclipse; this charge can be only roughly estimated now, but it should not exceed $984 regardless of the number of passengers or the amount of equipment involved.

The eclipse islands in the northern Cooks are the Danger Islands, Nassau, and Suwarrow (Suvarov). As von Klüber pointed out, the first of these lies only about 11 miles north of the central line of totality, with a probable duration of totality of about four minutes. There are three wooded islands, the principal one being Pukapuka, and some 700 inhabitants. Pukapuka is noted for its mosquitoes, so mosquito netting and chemical spray are essential at this island.

Suwarrow, a bird sanctuary that lies rather far from the central line of totality, is uninhabited, being last occupied some two years ago by a party of shell divers. Small vessels can enter the lagoon and anchor, except in northerly weather. It is doubtful that the old water tanks are in a fit state for use, so an expedition there would probably have to supply its own water. The island is noted for a terrific tropical storm that swept it in 1942, when occupants of a small yacht then anchored in the lagoon survived only by lashing themselves to the highest trees.

There appears to be sufficient clear land at Pukapuka, Nassau, and Suwarrow to make practicable von Klüber's proposal that expeditions land by helicopter. Such landing sites probably also exist at some, if not all, of the other islands.

Society Islands. Of the various main ports of entry to the eclipse area, Papeete on Tahiti undoubtedly has the best surface connections with the United States. There are calls every 60 days by vessels of the American Pioneer Line from Atlantic and Gulf ports. Union Line freighters, with limited passenger accommodations, also call at Papeete both en route from New Zealand and from the Pacific Coast. In addition, vessels of the Messageries Maritime Line, carrying passengers and cargo, serve Papeete from France, stopping there in both directions on voyages that terminate in Sydney, Australia. Papeete also lies on the "coral route" of TEAL.

In the French islands, there is no regular connection to Scilly or Mopélia, both of which are uninhabited. Labor parties go to them from time to time to make copra, and local schooners touch there only infrequently.

It is possible, however, to engage the American auxiliary schooner *Nordlys* to make a special trip, depositing eclipse observing expeditions at Scilly and Mopélia and returning for them after October 12th. When the owner of this vessel was in the Cook Islands recently, he quoted tentatively a fee of $3,000 to charter his vessel and services for a month, permitting observers to be on the islands some three weeks before the eclipse. This charter fee would include all transportation costs.

Mopélia is the only island other than Suwarrow where vessels can enter a pass in the coral reef. In fact, ships of up to 200 tons can be sheltered at Mopélia in almost any weather. This island achieved fame in the first world war, when Count von Luckner's raider, *Seeadler*, was wrecked by a storm there while the vessel was being careened for repairs.

The author, Frank M. Bateson, is seen here in his observatory, alongside the 8-inch Grubb refractor with which he principally observes variable stars and planets. Mr. Bateson, a member of the variable star commission of the International Astronomical Union, is at present visiting the United States.

Expedition Authorizations and Weather. Permission for any expedition to the French islands should be sought beforehand through American official channels from the governor at Papeete.

As for the New Zealand dependencies, the amount of land that is suitable for the use of an eclipse expedition is limited. Official application should be made through authorities in the United States, and it will undoubtedly be transmitted to the American Embassy in Wellington. There official advice can be obtained from the special subcommittee of the New Zealand IGY program that is dealing with eclipse matters. (The writer's views on these matters of procedure should not be taken as official.)

The director of the New Zealand Meteorological Service, Dr. M. A. F. Barnett, has supplied the subcommittee with extensive weather data on the South Pacific. This would doubtless be made available to any approved expedition. However, there is a lack of meteorological information from most of the islands, at least for any significantly long period.

The best that can be done is to reason from the general weather trends for this region and to use the sunshine records at Apia, although the comparison is not necessarily valid. Unlike the eclipse islands, which are low-lying coral atolls, Apia lies on the northern coast of a mountainous island about 50 miles long. It is estimated that at the eclipse sites there is a 60-percent chance of the skies being clear at the local times of totality. This chance is probably slightly greater for the French islands and slightly less for the other ones.

These are typical native houses at Pukapuka, one of the three main Danger Islands (see map on page 539, October, 1956, issue). Their roofs are thatched with leaves of the pandanus plant, and the walls are of native wood or of lime concrete made with coral taken from the lagoons. Though dry, cool, and airy, a South Seas home is not suitable as a darkroom or an instrument shelter.

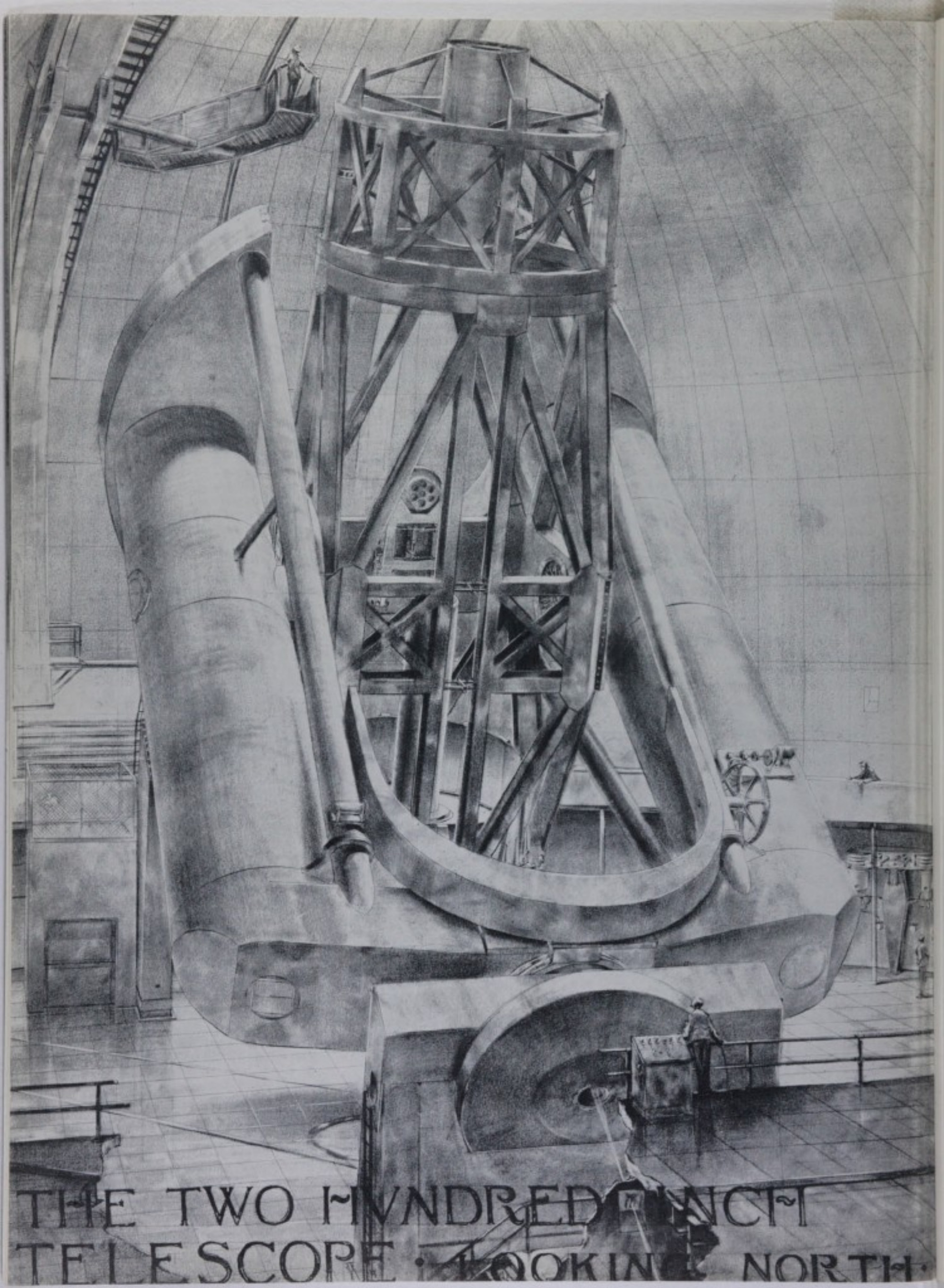
Equipment and Supplies. The inhabitants of the islands are Polynesians, a happy, laughter-loving people renowned for their hospitality. But these islanders have had comparatively little European contact and their standards of living, while suitable to their environment, are primitive by our ideas. The economic system is firmly anchored to the production of copra, made from the dried flesh of the coconut for the purpose of extracting oil.

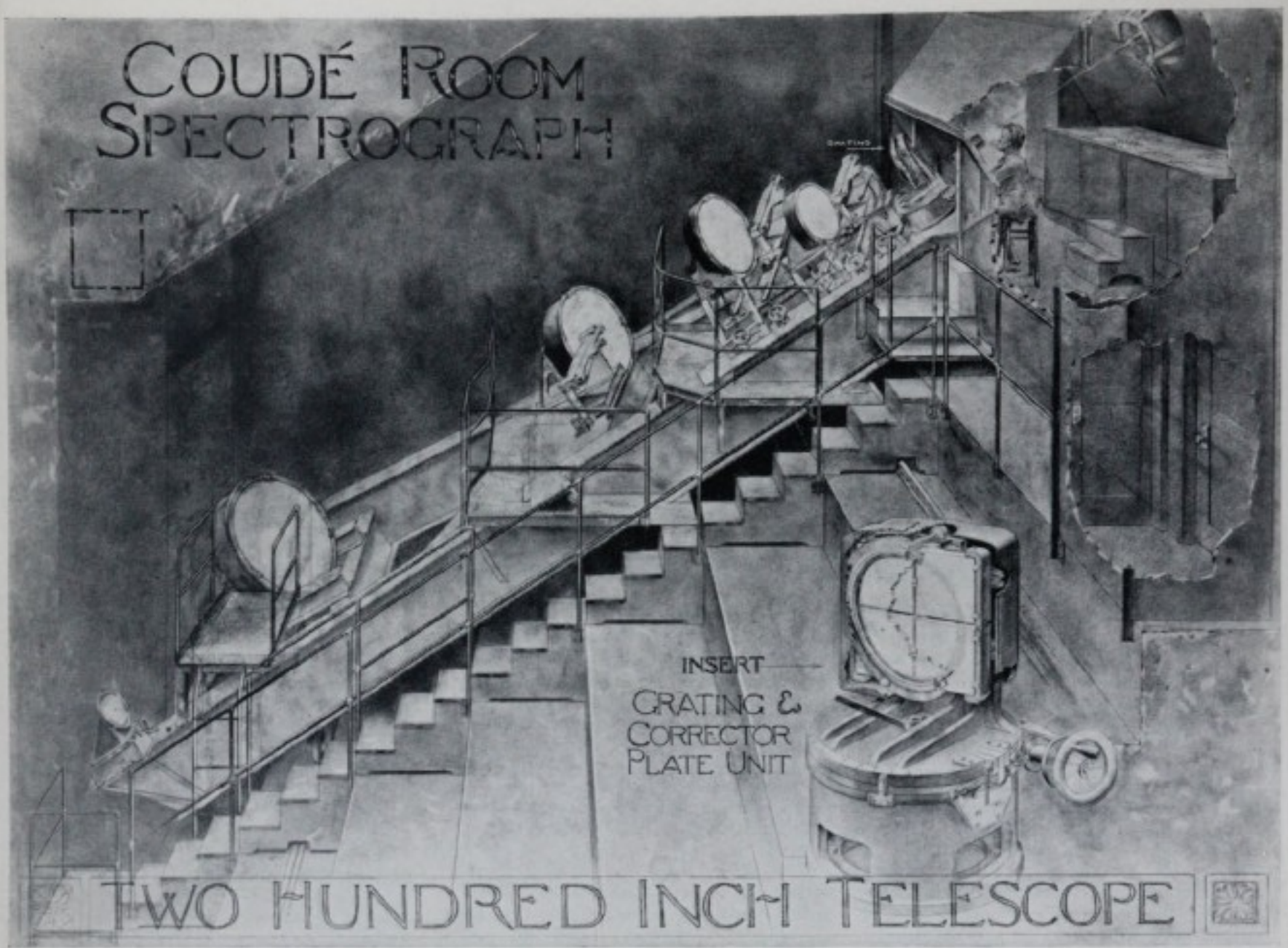
Therefore, any expedition to these Pacific islands would need to be self-contained in every respect. All food supplies, except coconut and fish that can be obtained by barter with the natives, must be brought in with the expedition. Living accommodations for most sites would best be in tents, which should have wooden floors as some protection against insects. Local buildings are in general not suited for instrument shelters or darkrooms; these should be prefabricated for erection by native labor, which requires adequate supervision. Domestic help can be secured without trouble on payment of local wages. Some of the islands have two-way radio communication with their principal islands.

Except for Mopélia and Suwarrow, landing is by canoe across open reefs. To provide against accident, everything should be packed in watertight containers, enclosed in outer cases. These should have carrying handles at both ends, permitting the cases to be lashed to the canoes should the seas be rough. The containers should be as small as possible, and experience shows that they should not exceed eight cubic feet, if possible. Their weight must not be too great, so they can be easily handled by two men, since at some islands it is necessary to carry such cargo some distance from the reef across the inner lagoon, especially at low tide.

Crossing the lagoon of the Danger Islands in a typical native outrigger canoe, going toward the island of Pukapuka. Women and children are riding in the canoe, while the men wade alongside.

ED. NOTE: The author of this article, whose address is P.O. Box 39, Avatiu, Rarotonga, Cook Islands, South Pacific, is at present visiting most of the principal observatories in the United States, on a lecture tour. His schedule is being arranged at the Flower and Cook Observatory, University of Pennsylvania, Philadelphia 4, Pa., and includes a lecture at Yale University on September 27th and one at Swarthmore College on October 11th. While here, he will be pleased to answer inquiries concerning local conditions in the South Pacific, especially on the Cooks and the French eclipse islands.


THE TWO HUNDRED INCH
TELESCOPE · LOOKING NORTH ·



In this drawing by Russell W. Porter, the light that on the facing page is seen issuing downward from the hollow polar axle is here followed into the spectrograph room, entering it at the extreme upper right. It passes the spectrograph slit, where the observer controls the position of the image, diagonally downward to the collimating mirror, which is at the extreme lower left. This mirror reflects the beam to the diffraction grating, where the light is dispersed into spectra of various orders. Each of the large mirrors is part of a camera, those farther from the grating having longer focal lengths, and the mirror nearest the grating being used for both the 18-inch and 8.4-inch cameras. The plateholders are the flat, narrow devices (plates are only one inch high), which may be moved into observing positions in front of the mirrors. As sketched in the lower right, the mosaic grating and correcting plate are mounted together. Compare this drawing with photographs of the actual equipment on the next page. All illustrations with this article are from Mount Wilson and Palomar Observatories.

Stellar Spectrographs — II

OTTO STRUVE, *Leuschner Observatory, University of California*

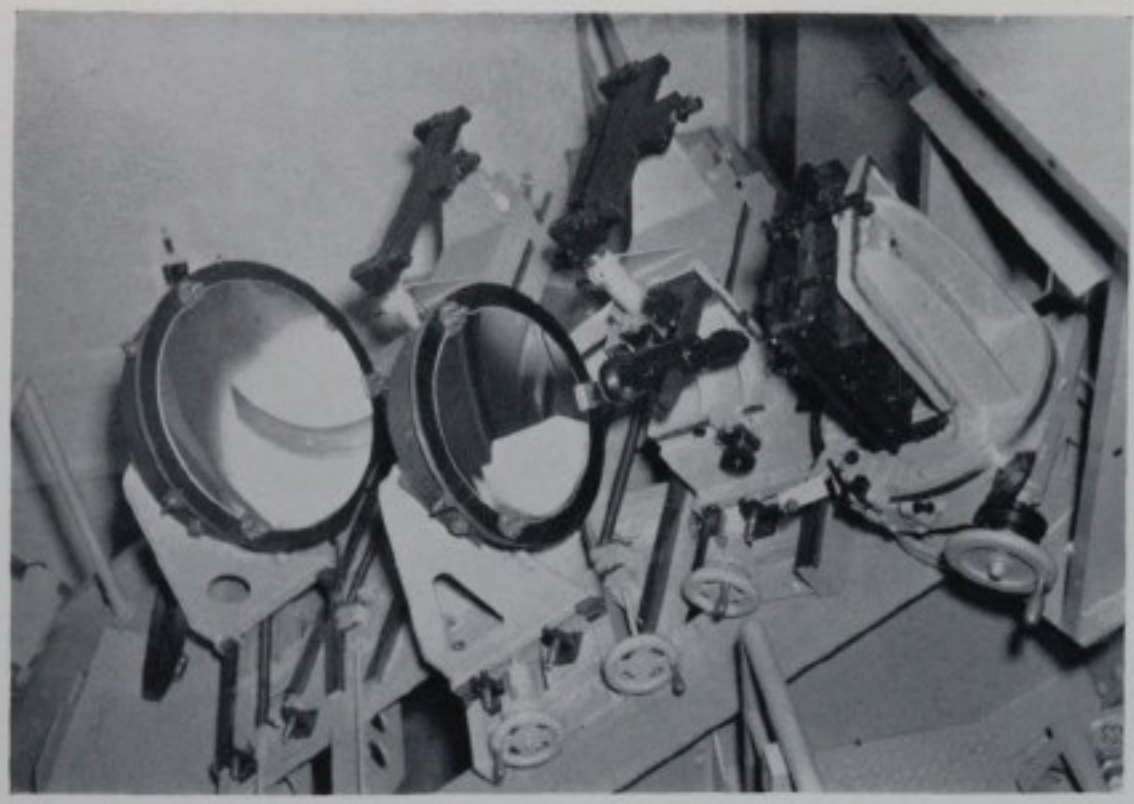
FACING PICTURE: Russell W. Porter made this design drawing of the Hale reflector at Palomar Observatory 10 years before this giant instrument went into use. A small part of the 200-inch mirror can be glimpsed at the bottom of the skeleton tube, between the yoke arms. For coude spectroscopy, light from the primary is deflected by smaller mirrors so that it passes down through the hollow polar axle to an opening (indicated between the words "hundred" and "inch") in the wall of the coude spectrograph room, which is partially revealed by the cutaway at the bottom of the picture. The appearance of this room is shown by the drawing above.

LAST MONTH, in the first part of this article, we saw how the astronomer's tools for the analysis of starlight have developed over the decades into the powerful spectrographs now in use on giant reflecting telescopes. The design of an efficient stellar spectrograph calls for a careful compromise among the conflicting demands of resolving power, speed, and dispersion.

For an example, let us review the general design problems of a grating spectrograph for the coude focus of the 100-inch reflector at Mount Wilson Observatory. The path of light to the spectrograph slit is shown by a diagram on page 538 of the September issue, and the arrangement of several cameras by that on page 539.

Since the resolving power of a 100-inch aperture is high, atmospheric seeing is the dominating factor that determines the size of a stellar image in the focal plane. For photography, the working size includes wandering of the image. In good seeing the effective diameter of a star is about one second of arc with the 100-inch reflector. Since the coude focal ratio is f/30, the linear diameter of the star image on the spectrograph slit is about 0.4 millimeter.

If the slit is made wide enough to admit



The short-focus cameras for the 200-inch coude spectrograph. The mirror at the left, 30 inches in diameter, is for the 36-inch Schmidt camera; its plateholder is at top center, moved out of observing position. (Above and to the mirror's right is the plateholder for the 72-inch camera, whose mirror is not shown.) The smaller mirror, 20 inches in diameter, is employed with either the 18-inch or 8.4-inch cameras, because an aplanatic sphere of quartz can be interposed to shorten the 18-inch focus to slightly less than half. This sphere, which has a concave rear surface (against the plate), is seen in the center of the picture below. The rectangular dark frame at the right mounts a correcting lens in front of the diffraction grating; the latter is also shown below, only the back of its support being visible here. The observing setup in these two pictures is for the 8.4-inch camera.

all the star's light to the collimator, and if the collimator and camera are of equal focal length, the width of a weak line in the spectrum will be 0.4 millimeter (each line being an image of the slit). If the linear dispersion or scale of the spectrograph is three angstroms per millimeter, the 0.4-millimeter width of a spectral line corresponds to 1.2 angstroms. Then, at a wave length of 5000 angstroms, the effective resolving power or purity of the spectrum is 5,000/1.2, or about 4,200.

But this is only a fraction of the theoretical resolving power of many large gratings. Last month we mentioned as typical a six-inch surface ruled with 20,000 lines to an inch, the resolving power being 120,000 in the first order.

The practical way to exploit the resolving power is to make the spectrograph slit narrower. Suppose it is only 0.01 millimeter wide, thereby narrowing each spectral line to 1/40 of its width when the slit is 0.4 millimeter across. The new resolving power is therefore 40 × 4,200, or about 168,000. In this case the spectrograph would utilize the full resolution of a very large grating, were it not for the grain of the photographic plate on which the spectrum is recorded.

Even with exceptionally fine-grained photographic plates, we cannot resolve two lines that are 0.01 millimeter apart, but ordinary good emulsions can resolve 0.02 millimeter. It is therefore preferable to admit more starlight by making the slit width 0.02 millimeter. In this case, the purity of the spectrogram would be about 84,000 in our example.

How large should we make the collimator, the concave mirror that forms a parallel beam of the light that has passed through the slit and feeds it to the grating? In practical design work, we usually start with the size of the best dispersing unit available, such as a grating with a surface of six inches. The collimator should have an aperture sufficiently large to serve the entire grating area, and its focal length should match that of the telescope itself. Thus, for the 100-inch reflector, which is f/30 at the coude focus, the collimator focal length has been made 30 × 6, or 180 inches, to match the 6-inch grating.

Our next consideration is the linear dispersion of the spectrum, which depends on the product of the focal length of the camera and the angular dispersion of the grating. The latter depends upon the total number of grooves, 120,000 in our example, divided by the aperture, six inches. The resulting quotient corresponds to 0.000118 radian per angstrom in the first order, provided the inclination of the grating to the incident light from the collimator is small.

Suppose the desired linear dispersion is three angstroms per millimeter. Then the focal length of the camera must be 3/0.000118, or 2,542 millimeters, which is about 100 inches. If we would be satisfied with a dispersion of 30 angstroms per millimeter, the camera need be only 10 inches long. The cameras of the 100-inch are actually made with focal lengths of 114, 73, and 32 inches, as shown in the diagram last month. The respective dispersions are 2.9, 4.5, and 10.4 angstroms per millimeter, at 4000 angstroms in the second order.

What is the proper slit width to use with each of these cameras? A very narrow slit permits high resolution, but it lessens the amount of starlight that reaches the photographic plate, thereby lengthening exposure times. A wide slit passes more of the light in the image, so fainter stars can be observed. But the slit width cannot be set without taking into consideration the ratio of the focal length of the camera to that of the collimator.

For example, if a slit width of 0.02 millimeter were used with the 114-inch camera, the projected width on the spectrum would be 0.02 × 114/180 or 0.013

The mosaic of four gratings (each 5½ by 7 inches) of the 200-inch coude spectrograph is seen at the upper right, with the dark frame that holds the correcting plate just in front of it. The correcting plate is of half strength, as light passes through it twice. In the center of the picture is the 18-inch camera plateholder, on which a tubular device carries plateholder and aplanatic sphere of the 8.4-inch camera. The spectrum photograph is less than an inch long. Part of the 18-inch camera's mirror cell is at the lower left.

millimeter. This is smaller than the resolution of the photographic emulsion. Hence, without an appreciable loss of purity, we can open the slit to 0.03 millimeter, thus admitting more light into the collimator.

In the case of the 73-inch camera, the factor is 73/180, and the slit width can be 0.05 millimeter; for the 32-inch camera it can be 0.11 millimeter. And with a very short-focus camera of only 10 inches, we could increase the slit width to as much as 0.35 millimeter, yet still have the projected width on the spectrum plate be only 0.02 millimeter. Since in good seeing the star image is only slightly larger than 0.35 millimeter, this would make an exceedingly fast spectrograph—nearly all the starlight collected at the coude focus will be used to form the spectrum. Of course, the dispersion would be much smaller than with the long cameras mentioned above.

These considerations make it clear that with any reasonable linear dispersion and camera length the bottleneck is no longer the theoretical resolving power of the grating. Instead, we can regard the purity of the spectrum as limited by the photographic emulsion. It is evident that an efficient spectrograph also must have the largest possible ratio of the focal length of collimator to that of the camera. To achieve such a favorable ratio, the collimator must be of large aperture, and the grating must be of matching size.

At Mount Wilson and Palomar Observatories, Director I. S. Bowen gave much attention to these points in designing the coude spectrograph for the 200-inch telescope. In *Vistas in Astronomy* (Volume 1, page 401), he says, "In view . . . of the enormous cost of collecting light by means of modern telescopes it is obviously of the greatest importance that the light once collected be used efficiently."

It is not yet feasible to rule a grating much larger than seven or eight inches wide, but the collimator mirror may be made considerably bigger than this. Bowen gave it an aperture of 12 inches, the dispersing unit consisting of four matched gratings, each having a ruled surface 5½ by 7 inches, with 10,000 grooves per inch.

The resolving power of the mosaic of four gratings is no better than that of each single element, about 70,000 in the first order. Yet in the second and third orders it is 140,000 and 210,000, respectively—ample for all camera lengths employed. Hence the gratings were not adjusted to bring them into the same phase relation. It was only necessary to mount them on adjustable supports so their spectra could be properly overlapped, thereby reinforcing one another in brightness. With this arrangement, Bowen has recorded the spectra of stars as faint as the 16th magnitude photographic, with a dispersion of 39 angstroms per millimeter and a purity of about 4,000.

Although this purity may seem small compared to the theoretical resolving power of the single gratings, it represents an enormous advance over all previous attempts to photograph the spectra of very faint stars. Bowen has remarked, "The combination of the Hale telescope and its spectrographs should . . . set the ultimate limit of object faintness that can be observed in the foreseeable future with a given dispersion and resolving power."

The shortest camera at the 200-inch coude has an effective focal length of 8.4 inches. Since the focal length of the collimator is 360 inches (just twice that of the 100-inch), the ratio of focal lengths is 1/43. Hence, the spectrograph slit can be opened to $0.02 \times 43 = 0.86$ millimeter without seriously reducing the purity of the spectrum. In good seeing, the diameter of a star image on the slit is 0.8 millimeter. Hence *all* of the light passing the slit is used in forming the spectrum, and the efficiency may be called 100 per cent.

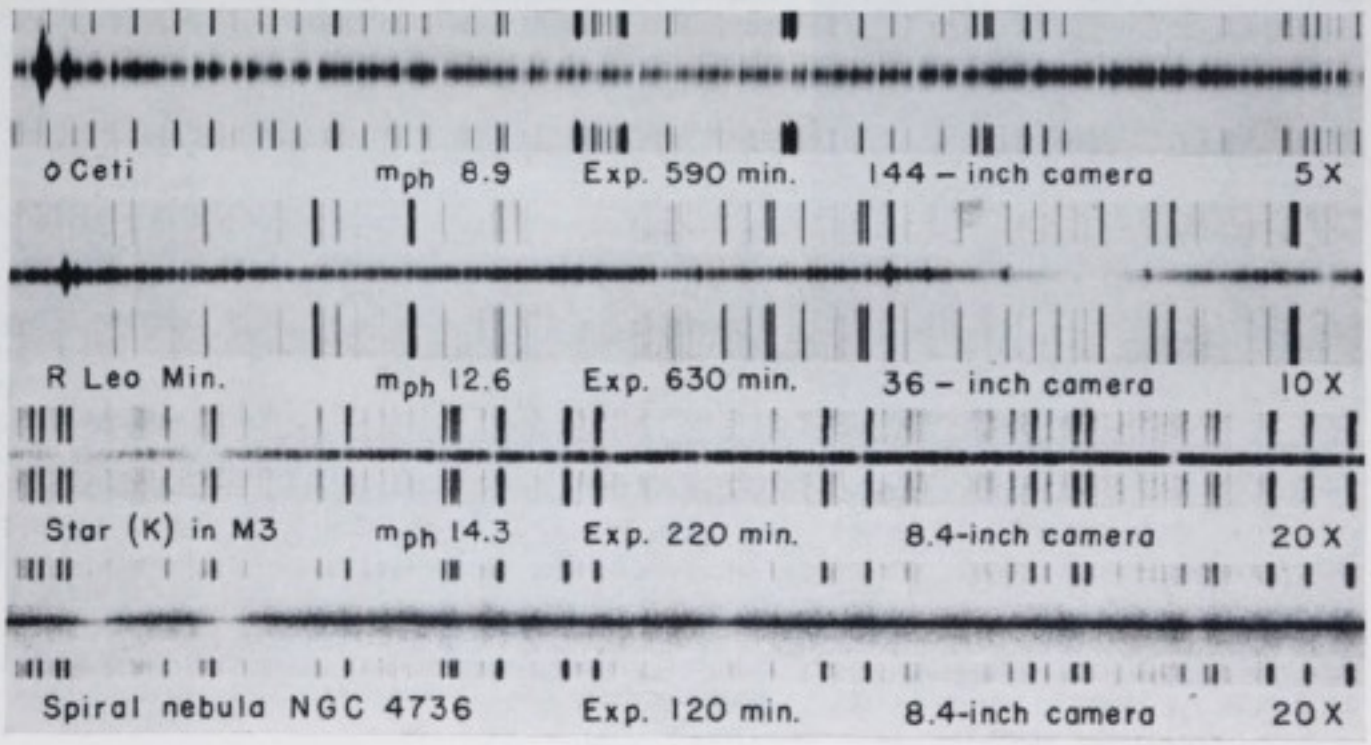
With the longer cameras, however, the relative efficiency is less. These are their respective focal lengths, dispersions in the third order at violet wave lengths, and efficiencies: 18, 36, 72, and 144 inches; 38, 18, 9, and 4.5 angstroms per millimeter; 50, 25, 13, and 6 per cent.

Bowen has considered various other possibilities of improving the efficiency of stellar spectrographs. Many years ago he invented an "image slicer" to be used at the slit, in order to change the round star image to a long narrow one, thereby sending more light into the slit. The device would be less valuable with a highly efficient camera of short focus, but in this case the image slicer could be used to produce a widened spectrum without requiring that the star image be moved back and forth along the slit.

New problems arise when the purpose of the observing astronomer is to measure wave lengths of the lines in a star's spectrum with high accuracy. The spectrogram is viewed with a measuring microscope, and the position of each stellar line ascertained with respect to comparison lines from a laboratory source, such as iron, for which the wave lengths are very accurately known.

Such measurements permit us to apply the Doppler principle to the star's spectrum; we interpret the small difference between stellar and laboratory wave length of each line in terms of velocity of approach or recession of the star (or its atmosphere). Very precise radial velocity measurements are needed to determine the relativistic red shifts in the spectra of normal main-sequence stars, or to discover planetary systems that may belong to other stars.

Consider, for example, a system like that formed by the sun and Jupiter. The orbital velocity of Jupiter is 13 kilometers per second, and its mass is about 1/1,000 the sun's. Therefore, the orbital velocity of the sun around the center of gravity of the sun-Jupiter system is 13/1,000 or 0.013



Four examples of coude spectrograms secured with the 200-inch telescope. The two upper spectra are of long-period variable stars, Mira Ceti and R Leonis Minoris, both observed near minimum light. Next come two spectrograms at lower dispersion, of a star belonging to the globular cluster Messier 3, and of the galaxy NGC 4736.

kilometer per second. If a star similar to the sun had such a planetary companion (which would be invisible at the distance of even the nearest star), is there any likelihood of spectroscopically detecting such a small orbital velocity in the primary star?

If the linear dispersion of the spectrograph is three angstroms per millimeter and the purity is about 100,000, we should be able to resolve two very narrow lines separated by only 1/20 angstrom. We ought to be able to measure the center of a sharp line with a precision 1/20 of this. Expressed in velocity units, this precision would be about 0.15 kilometer per second. And, by measuring not one but 100 lines, we could further improve the precision by a factor of $100^{0.5}$ to 0.015 kilometer per second.

Another way of computing this result starts from the fact that we can measure a single, sharp absorption line on a spectrogram to an accuracy of 0.001 millimeter. With the dispersion of three angstroms per millimeter, this would give for each line a precision of 0.003 angstrom, and for the mean of 100 lines about 0.0003 angstrom, or about 0.018 kilometer per second. Although this is not quite sufficient for the planet-detection problem, the accuracy can be further enhanced by measuring a large number of spectrograms, and perhaps by improving still further the dispersion and purity.

Present-day measurements with coude spectrographs have not reached this level. The best existing work in this field is by W. S. Adams with the 100-inch telescope. In 1941 he determined from 37 spectrograms that the velocity of Arcturus with respect to the sun is -5.621 ± 0.005 kilometers per second. From the same measurements he deduced the orbital velocity of the earth around the sun, which yielded for the solar parallax an excellent value: 8.805 ± 0.007 seconds of arc.

But while the probable error of a single spectrogram, determined from the internal agreement of the 25 lines measured on each plate, was ± 0.05 kilometer per second, the departures of the individual plate velocities from the mean value of -5.621 often amounted to several tenths of a kilometer on successive nights. Adams concluded that slight systematic sources of error must be present, and he suggested that they might be due "to the character of the arc which produces the comparison spectrum, and the general system of temperature control throughout the spectrograph."

It is probable that several other causes contributed to these systematic errors, such as changes in the collimation of the light from the star and from the comparison source, incorrect focusing of the stellar image on the slit, and atmospheric dispersion of the star image.

Nevertheless, if observers were to regard the spectrograph as a precision measuring instrument, in the same critical spirit as the positional astronomer treats a meridian circle, we should be able to tackle a vast number of problems similar to those cited above. These would include the determination of perturbations in the orbits of spectrographic binaries, and the dispersion in the radial velocities of the brighter members of a galactic cluster.

COMET 1957D – AN UNEXPECTED VISITOR

(Continued from page 572)

the nucleus of Comet Mrkos appeared brighter, relative to the comet as a whole, than did the nucleus of Comet Arend-Roland. L. J. Robinson and other members of the Los Angeles Astronomical Society saw the nucleus on the morning of August 4th as very large, and elongated at right angles to the axis of the comet. (The early observations of these amateurs were made with a portable 16-inch reflector as a follow-up on Mr. Cherbak's report.) In a 10-inch telescope, the nucleus appeared three-lobed to Walter S. Houston, at Manhattan, Kansas, on August 10th. To the naked eye, the starlike nucleus of Comet Mrkos helped make it a very striking object.

The form of the comet's tail close to the head shows on this large-scale photograph by Strathmore R. B. Cooke, Minneapolis, Minnesota, with his f/5 12¼-inch Newtonian reflector. He used Panatomic-X film for a 10-minute exposure beginning at 8:25 p.m. Central standard time, on the 23rd of August.

Comet 1957d was closest to the sun on August 1st, the perihelion distance being 0.355 astronomical unit, or about 33 million miles. At that time the comet-earth separation was 110 million miles, and this gradually became less for the next two weeks, being 100 million miles on August 15th. By August 30th, the comet was 0.820 astronomical unit from the sun and 1.261 units from the earth.

Observations of the magnitude of a comet are often uncertain, and in twilight, haze, or moonlight the brightness may be greatly underrated. During the first 10 days of August, Comet Mrkos was generally estimated as about 2; by the 15th it was still about 2.5, for while the comet was becoming more distant from the sun it was still approaching the earth. Then, as it receded from both the earth and the sun, the fading was more rapid, and the comet became too faint for naked-eye observations by early September. For details of the predicted brightness, and for an ephemeris of the comet's path, see page 606.

OPTICAL SOCIETY OF AMERICA

The 42nd annual meeting of the Optical Society of America will be held at the Deshler-Hilton Hotel, Columbus, Ohio, October 17-19. There will be sessions on physiological optics and on atmospheric transmission in the infrared. A trip to the Perkins Observatory is also scheduled.

QUESTIONS... FROM THE S+T MAILBAG

Q. How could Comet Mrkos be seen both in the northwest after sunset and in the northeast before dawn, as stated on page 582 of the September issue?

A. Because for the first part of August the comet and the sun were at nearly the same right ascension, but the comet was 20 degrees or more of declination north of the sun. Although it was not circumpolar in mid-northern latitudes, its maximum declination of about +38° being reached on August 10th, it was below the northern horizon for only a few hours each night. Had this comet been 10 degrees farther north, it would have been circumpolar for an observer at 42° north latitude.

Q. In the Chesley Bonestell portrayal of a lunar landscape in the center of the August issue, why do the shadows thrown by the earth's light diverge so strongly? As the earth is some 240,000 miles away, should not the shadows be practically parallel?

A. The artist has included the effect of perspective. The observer is located high up on the side of the crater wall, as if he were on a bridge overlooking a railroad yard full of parallel tracks, which would seem to meet in the distance.

Q. What is the latest determination of the inclination of Mars' equator to the plane of its orbit?

A. In 1954 H. Camichel in France found 24.80 degrees for this angle, which is the Martian analogue of the obliquity of the ecliptic. His value may be uncertain by a few tenths of a degree, but it is probably much more reliable than any previous determination. W. E. S.

NEWS NOTES

OBJECT SCHUBART

At Sonneberg Observatory, East Germany, the sky is systematically patrolled with small cameras to record the light changes of variable stars. On July 13th, when J. Schubart was examining some of the patrol photographs taken July 3-5, he discovered a fast-moving, starlike object of the 11th magnitude. It was reobserved with longer-focus telescopes at Sonneberg and Potsdam, as it moved from Delphinus into Aquarius. Subsequently, the object was traced back on Sonneberg patrol plates as far as May 25th, when it was of magnitude 12.5.

Dr. Schubart's preliminary calculations showed that he had found a new asteroid of the Albert-Alinda group which has a very unusual orbit. It travels in a highly elongated ellipse, the eccentricity being 0.395 and the period 4.3 years. A. Patry, a French astronomer, suggests the new object may be the same as the lost minor planet 1929 SH, hitherto known only from four photographs taken 28 years ago.

When Object Schubart passed through perihelion on July 17, 1957, it was only 105 million miles from the sun and just outside the earth's orbit. At aphelion it will be about 80 million miles outside the orbit of Mars. The asteroid orbit's inclination to the plane of the ecliptic is about 8½ degrees, according to the elements given in *Circular* No. 1616 of the International Astronomical Union.

ANTARCTIC ECLIPSE

On October 23rd the sun will appear partially eclipsed from portions of South Africa, Madagascar, and New Zealand. But totality will be limited to a small region in the Antarctic, in the Weddell Sea off Bruce Coast.

There the conical shadow cast by the moon will graze the earth's surface, but the shadow axis will not. The closest approach of the shadow axis to the ground will be 33 kilometers, with 37 kilometers for the corresponding radius of the shadow cone.

These unusual geometrical conditions make this eclipse a favorable opportunity for studying changes in the earth's ionosphere—the ionized atmospheric layers that can reflect radio waves—as the moon briefly shields it from direct solar radiation. At heights of 100, 200, and 300 kilometers above the earth's surface, the maximum duration of totality will be 80, 88, and 94 seconds, respectively, according to Mrs. Simone D. Gossner, of the U. S. Naval Observatory.

The axis of the umbral shadow will intersect each level of the ionosphere twice. Hence there will be two regions on the earth's surface from which observations of ionospheric changes could be made by recording the echoes of radio signals transmitted vertically upward. One of these includes Queen Maud Land and Coats Land, which are relatively inaccessible. The other, in the general area of Palmer Peninsula, south of the tip of South America, is more easily reached by the IGY expeditions in the Antarctic.

ORBITAL MOTION OF THE EARTH

Observations have shown that the obliquity of the ecliptic—the tilt between the earth's orbital and equatorial planes—is actually diminishing faster than existing calculations of planetary motions permit. This effect, according to R. L. Duncombe and G. M. Clemence, U. S. Naval Observatory, is probably the outstanding discordance at the present time between observation and theory in the motions of the planets.

The two Washington astronomers have traced this discrepancy to its source. The predictions of the sun's position in the national ephemerides are based on Simon Newcomb's *Tables of the Sun* (1898). These tables were compared with a precise step-by-step integration of the equations of the earth's motion, over the years 1920 to 2000, that had been computed by Paul Herget, Cincinnati Observatory. The comparison showed that Newcomb had underestimated the 47-second-of-arc change per century in the obliquity by about one per cent; the discrepancy arose from incompleteness of his calculations.

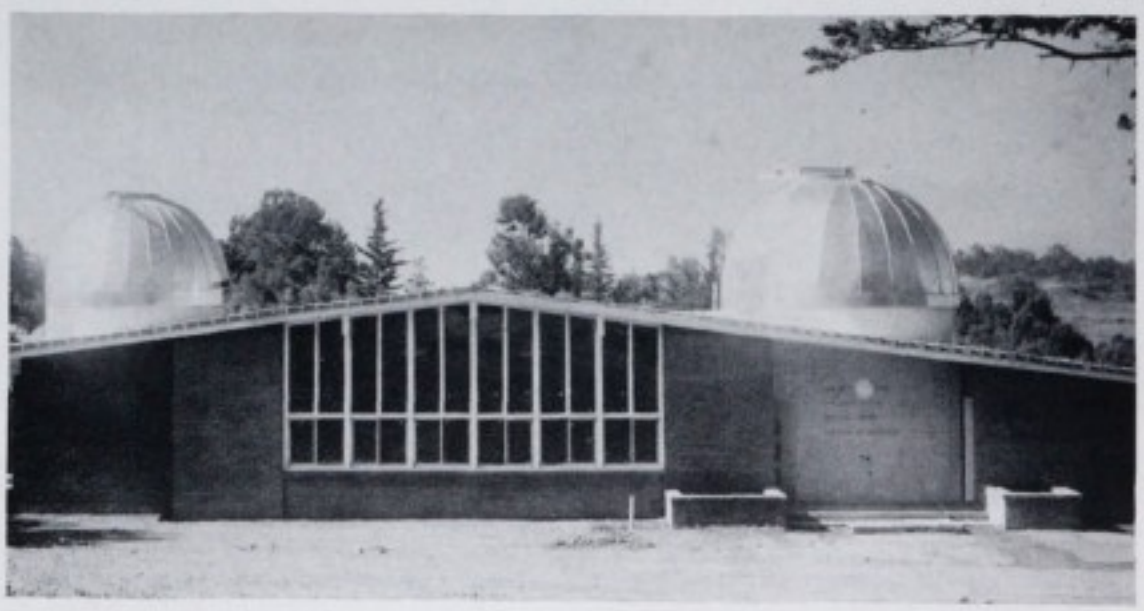
A number of other small inadequacies in Newcomb's theory of the earth's motion were uncovered, such as the omission of a periodic perturbation of the earth's latitude, arising from the attraction of Saturn. Drs. Duncombe and Clemence have concluded that a comprehensive new derivation of the detailed formulas of the earth's orbital motion is needed.

WESTMONT COLLEGE

The Westmont College Observatory, Santa Barbara, California, was formally dedicated on June 1st. The two domes of the new building house a 6-inch refractor and a 16½-inch Newtonian-Cassegrainian reflector, both designed and built by George A. Carroll, who donated the telescopes to the college.

Equipped for photographic, spectroscopic, and micrometric work, the reflector has a Cassegrainian focal length of 320 inches and a motor drive. For field-trip use, the 6-inch refractor can be dismantled and mounted on a portable tripod. Other instruments will be added later.

Besides providing room for astronomy study, the building has a large classroom for science courses. Peter Stoner, chairman of the college's division of natural sciences, is in charge of the observatory.



The new observatory of Westmont College, Santa Barbara, California.

IN THE CURRENT JOURNALS

A RADIO TELESCOPE, by John Firor, *QST*, September, 1957. "The antenna system described here is a type suitable for tracking the Earth Satellite, provided there is sufficient spacing (500 to 1000 feet) between elements. The receiving method discussed has been developed to separate star noise from ordinary background noise and, while it could be simplified a bit for the c.w. signal to be transmitted by the satellite, is well suited for calibrating a satellite-tracking antenna. . . ."

THE PLASMA JET, by Gabriel M. Giannini, *Scientific American*, August, 1957. "These ventures in applied science all involve fundamental questions which apply to the great bulk of matter in the universe. Obviously plasma behavior must underlie much of the internal dynamics of stars. The theory of magnetohydrodynamics itself had its beginnings in the pure science of astrophysics. It was first developed to explain certain motions within galaxies, the galaxies being treated by the theory as a gas of stars and dust encompassed in electrical and magnetic fields of truly huge dimensions in terms of space, time and energy content."

Classification, Dimensions, and Distances of Bright Southern Galaxies

GERARD DE VAUCOULEURS, *Lowell Observatory*

DURING the years 1952 to 1956, many photographs of bright galaxies in the southern heavens were taken by the writer at Mt. Stromlo Observatory in Australia, mostly with the 30-inch Reynolds reflector, and later with the new 74-inch telescope. This survey was described in the September issue of *Sky and Telescope*, where photographs of some of the more interesting of the southern galaxies were reproduced.

In the course of this survey, the need for a more comprehensive classification system for galaxies was strongly felt. After some illuminating discussions with A. R. Sandage in 1955, a revised scheme was adopted, incorporating the improved Mount Wilson-Palomar system of E. P. Hubble and Sandage, as modified and supplemented by the Mt. Stromlo work.

Hubble's original classification scheme of 1925 is illustrated here, the galaxies being divided chiefly into ellipticals, normal spirals, and barred spirals. The direction of any possible evolution along this sequence has not been generally agreed upon. If the original Hubble scheme were to be called a Mark I model, the revised but unpublished Hubble-Sandage system might be regarded as Mark II, and the writer's present system as Mark III.*

In the chart on the facing page, the new system is illustrated schematically, the diagonal spokes representing four main structural series, **SA(r)**, **SA(s)**, **SB(r)**, and **SB(s)**. Compact galaxies are in general toward the center, more open and irregular systems toward the outside, the concentric circles marking corresponding stages.

Classes. These four main galaxy types are seen on the chart, beginning with ellipticals, **E**, at the center. Next outward are the lenticulars, **S0**, then the spirals, **S**, and the irregulars, I (not shown).

Stages. These are subdivisions of the classes. Again working outward, we have for the lenticular galaxies early, intermediate, and late stages, designated **S0⁻**, **S0°**, and **S0⁺**, respectively. Then come the spirals through increasingly open types, **a**, early; **b**, intermediate; **c**, late; **d**, very late; and **m**, Magellanic. The last of these forms a transition between the spirals and completely irregular galaxies, **Im**, similar in appearance to the Magellanic Clouds, but without their residual spiral structure. Non-Magellanic irregulars, such as Messier 82, are designated **I** or better **I0**, since they show some analogies with the **S0** class.

Families. We distinguish two families of spiral galaxies, ordinary, **SA**, and barred, **SB**, with intermediate objects designated **SAB**. The lenticular galaxies are similarly subdivided, as the chart shows, with quadrant labels.

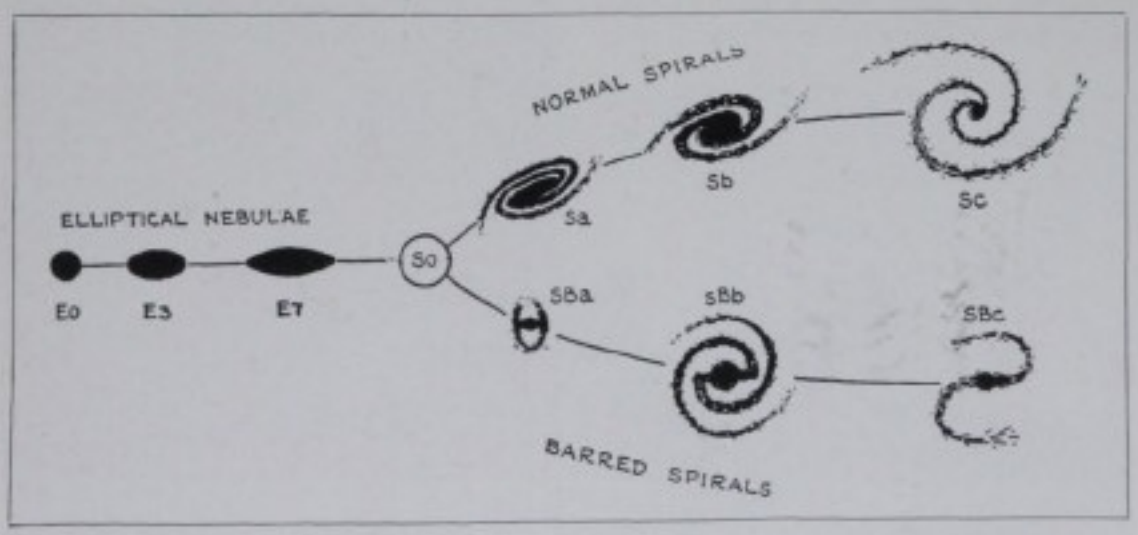
Varieties. There are two main varieties of lenticulars and spirals: ringed (**r**) and spiral (**s**), with intermediate objects (**rs**), as shown by the labels along the edges of the chart.

Outer ringlike structures, denoted by the prefix (**R**), are frequently observed near the transition stage between lenticulars and spirals, called **S0/a** by Hubble. These features are discussed in the *Astronomical Journal, 62*, 13, 1957.

This revised classification and its system of notation are illustrated by the Mt. Stromlo photographs on the following pages. The apparent frequency of the different types among the galaxies of the Shapley-Ames catalogue that have been reobserved from Mt. Stromlo is **E**, 23.4 per cent; **S0**, 21.0; **SA**, 24.4; **SB**, 26.3; the remaining 4.9 per cent is made up of irregular and peculiar objects.

In the Mt. Stromlo survey, much attention was paid to the dimensions of the galaxies. Apparent sizes determined by direct measurements on photographs have fallen into disrepute during the last two decades, since such dimensions fall far short of the extent detectable on microphotometer tracings. Moreover, they also depend greatly on the particular set of instrumental circumstances that determine the detection threshold. To remedy this defect, about 10 years ago the writer introduced the concept of "effective dimensions"—the size of the isophote or best-fitting ellipse within which is emitted half the total photographic luminosity of a galaxy. This method has been described in detail in two papers, *Annales d'Astrophysique, 11*, 247, 1948, and *Monthly Notices* of the Royal Astronomical Society, *113*, 134, 1953.

Effective dimensions, though preferable, are rather laborious to measure. How-

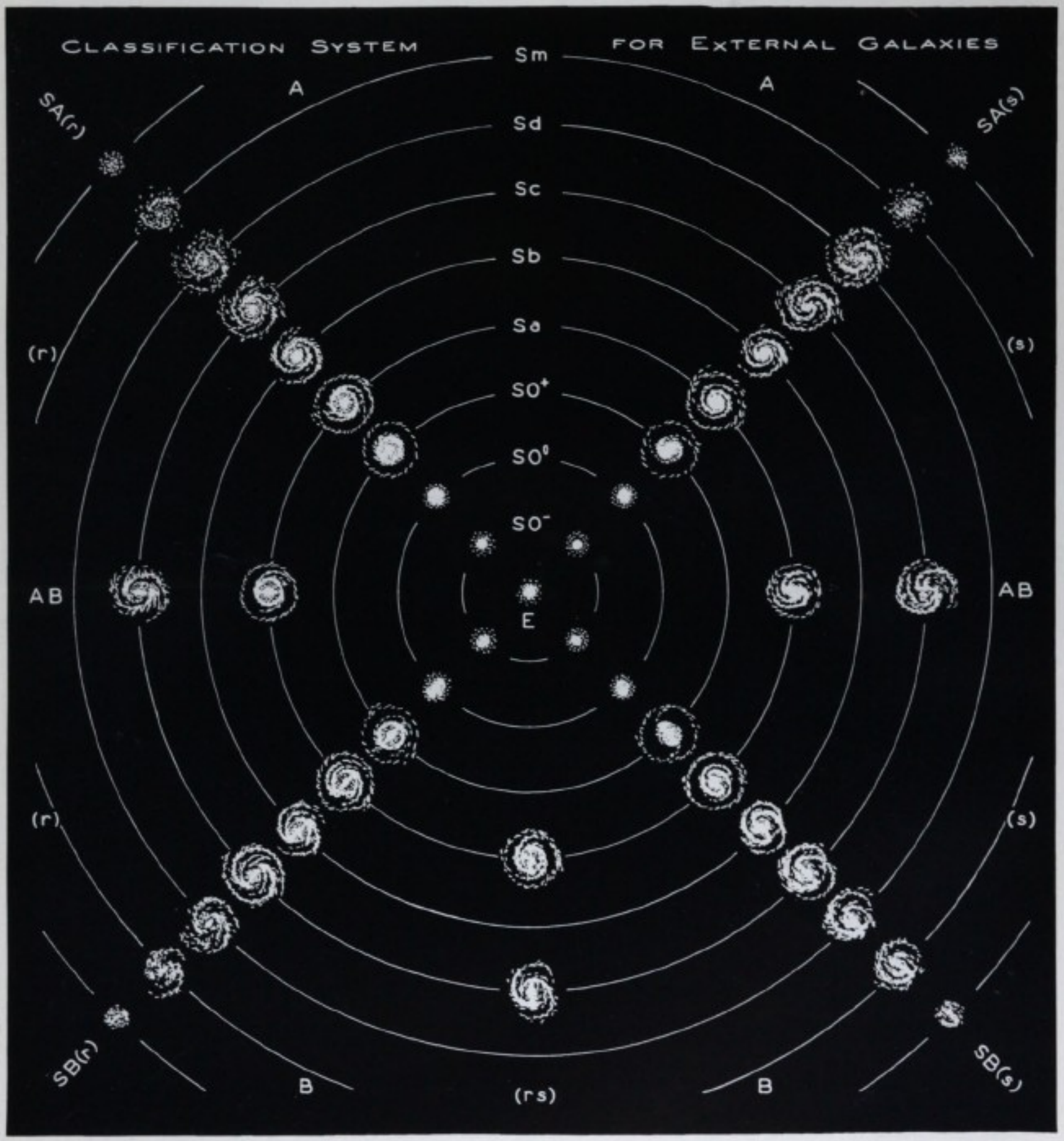


E. P. Hubble introduced this standard system of classification of the forms of galaxies some 30 years ago, from the study of photographs taken with the 60- and 100-inch reflectors at Mount Wilson Observatory. There are two families of spirals. The elliptical galaxies appear almost featureless, while S0 represents a transition form in which some structure, not spiral, can just be detected. Irregular galaxies fall outside this scheme. From "The Realm of the Nebulae."

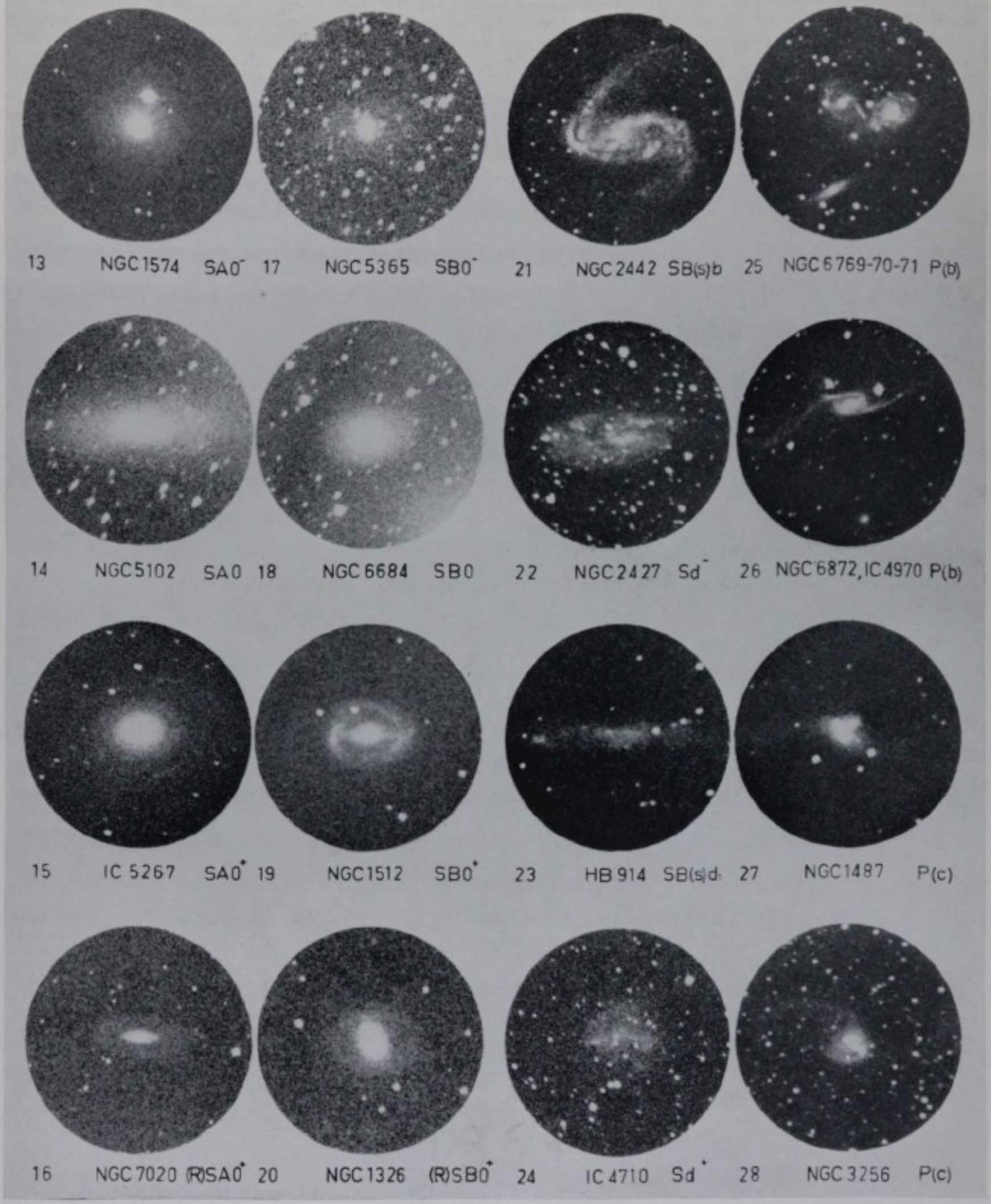
*A Mark IV version incorporating some further slight revisions was presented at the third symposium on cosmical gas dynamics in Cambridge, Massachusetts, June, 1957. It will be published in the proceedings of the symposium and described with detailed illustrations in the forthcoming Volume 53 of the *Handbuch der Physik*.

ever, it was found that useful size data could be obtained by direct measurement on a homogeneous set of negatives; such a system of photographic dimensions can be reduced to a standard system by fairly small, well-defined corrections. In the Mt. Stromlo survey, dimensions reduced to standard conditions are given for both the bright, inner regions and for the faint, outer parts. The former are comparable to the sizes noted in the early photographic surveys at Lick, Heidelberg, Helwan, and elsewhere, while the latter are comparable to the data from the modern surveys at Harvard, Lick, and Mount Wilson.

For example, let us compare the Mt. Stromlo diameters with the Harvard reobservations of a fraction of the Shapley-Ames galaxies, as published in Harvard Observatory *Annals, 88,* No. 4, 1934. For objects in common, we find that the Harvard outer diameters are on the mean 1.2 times the Mt. Stromlo values,

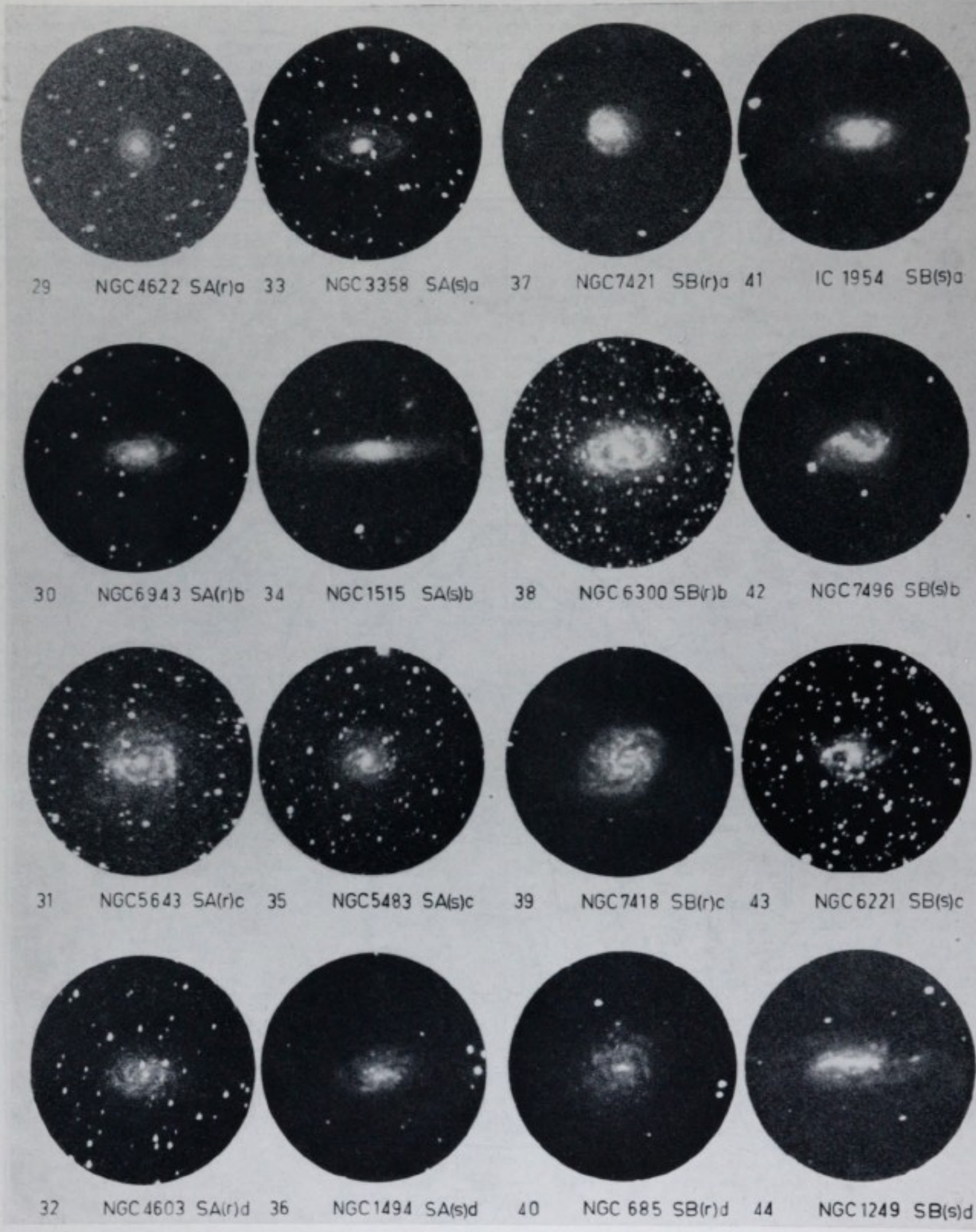


Forty-three of the possible types of galaxies and their relationships are represented schematically in this chart by G. de Vaucouleurs. His system of classification is based on the appearance of galaxies on photographs taken with large telescopes. It is purely descriptive, and does not depend on any evolutionary hypothesis. In the upper half of the chart are ordinary spirals (SA), in the lower half, barred spirals (SB). Systems with ring structure (r) are at the left, those without rings (s) at the right. A few mixed types intermediate between normal and barred spirals are shown along the horizontal diameter of the diagram, and some transitions between ring and nonring types along the vertical diameter. In each of the sketches, dashes are used to indicate structures composed predominantly of Population I stars, and dots for those of Population II.



These photographs of southern galaxies were taken with the 30-inch Reynolds reflector of Mt. Stromlo Observatory in Australia, and form a sequel to the album of southern galaxies in Dr. de Vaucouleurs' article last month. Pictures 13 to 20 have been chosen to illustrate the principal stages in the two main sequences of ordinary and barred lenticular galaxies. Note in 16 and 20 the outer ring structures characteristic of the transition stage S0/a. Pictures 21 to 24 are late-type ordinary and barred spirals of low surface brightness, forming transitions to the Magellanic irregular galaxies. The fourth column illustrates interacting pairs, P(b), and colliding pairs, P(c). Note the curious straight link between NGC 6769 and 6770, and the anomalous, distorted arm of NGC 6872, apparently due to interaction with the small elliptical galaxy IC 4970.

The original negatives of both the colliding pairs, NGC 1487 and NGC 3256, show faint outer "tidal" filaments.

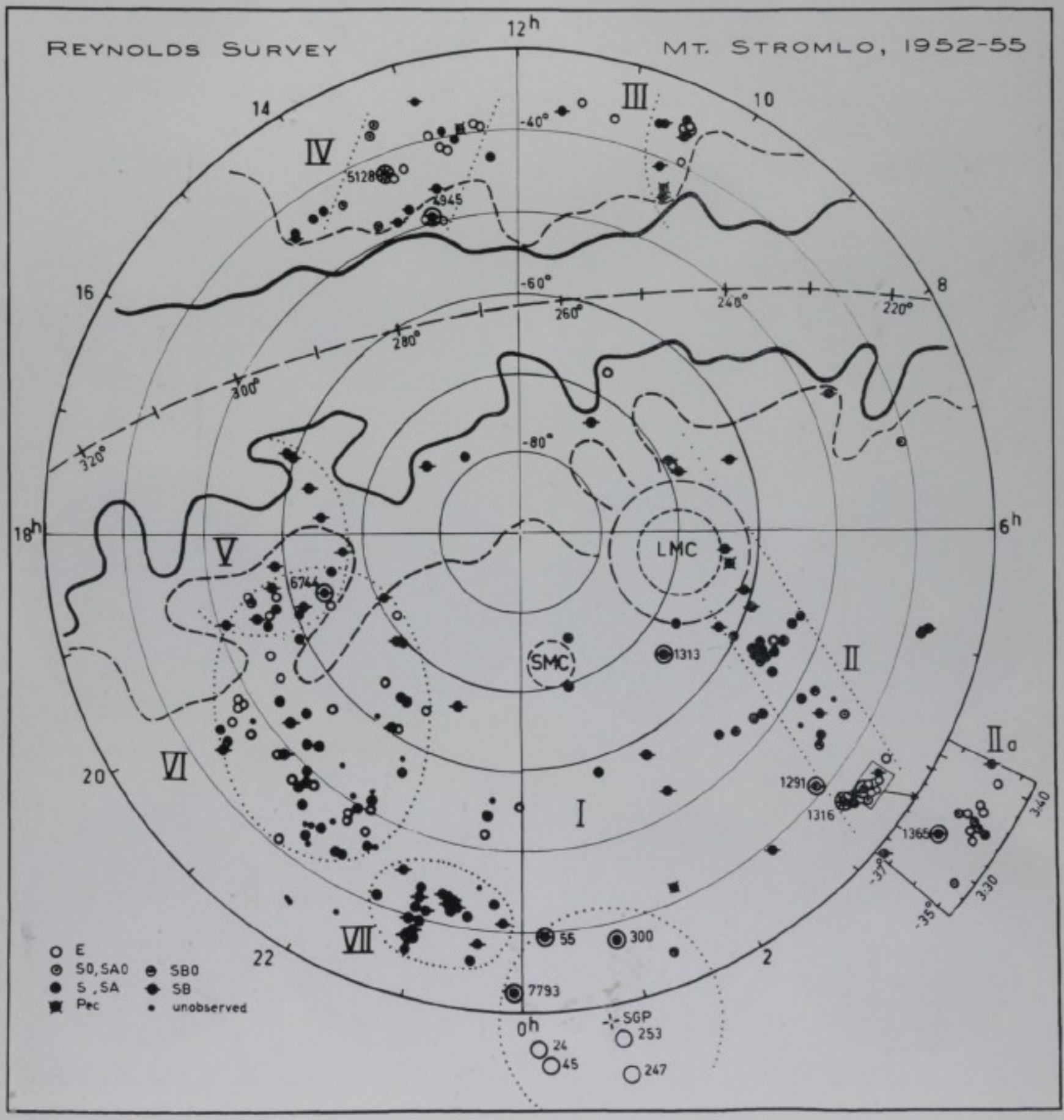


A further selection of Mt. Stromlo photographs illustrates the principal stages in the four main sequences of ordinary and barred spiral galaxies: SA(r), SA(s), SB(r), and SB(s). Because of the rather small plate scale and the limited number of bright objects suitable for reproduction, a typical galaxy is not shown for every subdivision; in some cases intermediate types had to be used. Poor resolution or unfavorable tilt may require eventual reclassification for some of these objects. Nevertheless, the main trends and characteristics can be recognized fairly clearly on comparison with the key chart on page 583. In such a comparison, proper allowance must be made for the effects of asymmetry and tilt, particularly in the SB(s) sequence; in the key chart all the galaxy types are drawn as seen face-on, that is, without foreshortening of their principal planes. The same difficulties arise in any system of descriptive classification of galaxies.

with an average deviation of only ±8 per cent. This ratio is 1.25 for the elliptical galaxies and 1.18 for spirals.

For objects in the Shapley-Ames catalogue that have been observed in the Mt. Stromlo survey, the median outer diameters are, for different classes: **E**, 1.4 minutes of arc; **S0**, 2.0; and **S**, 3.2. However, apparent diameters depend on apparent flattening or tilt, and a correction, independent of type, must be applied before significant comparisons can be made. On the average, a galaxy whose plane is tilted 30 degrees to the line of sight (axial ratio 0.5) appears about one-third larger than if it were seen face on; it appears two-thirds larger when the axial ratio is 0.25, as is the case for edgewise **E7** ellipticals and for spirals tilted at 10 to 15 degrees to the line of sight. The correction factor may be as large as two for the most flattened spirals seen exactly edgewise. This is the reason earlier statistical studies of galaxies seemed to indicate a large excess of edgewise objects, as compared with a random distribution of orientations.

For galaxies that have the same type in



Bright galaxies photographed during the Mt. Stromlo survey and contained in the Shapley-Ames catalogue are plotted on a map centered on the south celestial pole, with its circumference at −30° declination. The dashed curve marks the central line of the Milky Way, whose dust clouds absorb at least two magnitudes within the area bounded by the heavy, irregular lines; similarly, dashed lines indicate the limits of 0.5-magnitude absorption, and there is absorption inside the Large and Small Magellanic Clouds, LMC and SMC. The galaxies are mainly concentrated into great groupings, which Dr. de Vaucouleurs has labeled with Roman numerals to correspond to the regions in the table of distances on the facing page. Some NGC numbers are included, and larger symbols indicate large objects.

the revised system, the observed apparent diameters reduced to "face-on" orientation values may be used as indicators of the relative distances of different clusters or groups of galaxies. The accompanying chart shows the apparent distribution of all the Shapley-Ames galaxies south of declination −35°. It is obvious that these nearby objects are not distributed at random, but are strongly clustered in a small number of clouds or regions outlined by the dotted contours. The relative distances, based on apparent inner and outer diameters of ellipticals, lenticulars, spirals, and of the inner ring structures, in each region are in excellent accord, as shown in the accompanying table. Here the well-defined average distance of the great Pavo-Indus cloud (region VI) is adopted as a unit. This unit is approximately 10 million parsecs, according to a provisional absolute calibration of the rings, on the assumption that the red shift increases by 180 kilometers per second for each million parsecs of distance (see *Astronomical Journal, 62,* 13, 1957).

RELATIVE DISTANCES, IN MILLIONS OF PARSECS, FROM APPARENT DIAMETERS OF MEMBER GALAXIES OF SEVEN REGIONS

Region	*Ellipticals*		*Lenticulars*		*Spirals*		*Rings*	*Average*
I	—	—	7.6	6.0	7.0	7.2	7.3	7.1
II	8.0	7.8	7.5	7.0	6.8	7.2	8.1	7.5
III	7.8	8.2	—	—	7.7	6.1:	8.2	8.0
IV	8.2	10.0	8.2	7.0	8.5	8.6	8.5	8.5
V	—	—	—	—	7.6	7.0	6:	7.0:
VI	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
VII	—	—	—	—	6.6	6.3	7.7	7.0

For each type of galaxy, two sets of distances are given, determined from the inner and outer dimensions, respectively. For the Pavo-Indus region VI, the distance has been adopted as 10.0 million parsecs. Less certain values are marked by colons.

The nearest concentration of external galaxies in this part of the sky is the well-marked group of spirals in Grus (region VII), which is unusual in being almost free from bright ellipticals or lenticulars. Still nearer, at one to three million parsecs, are a dozen foreground objects of large apparent diameter; the most remarkable grouping of such nearby objects is near the south galactic pole, and includes the large spirals NGC 24, 45, 55, 247, 253, 300, and 7793.

Planetarium Notes

(Most planetariums give group and special showings by appointment.)

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: Monday (Sept.-June), 3:45 p.m.; Thursday, 7:15, 7:45, 9 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BLOOMFIELD HILLS, MICH.: *McMath Planetarium.* Cranbrook Institute of Science, Bloomfield Hills, Mich.

SCHEDULE: Saturday and Sunday, 2:30 and 3:30 p.m. Spitz projector. In charge, Robert T. Hatt.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR 4100.

SCHEDULE: Sunday, 2:30 to 5 p.m. (except summer). Admission free. Spitz projector. Director, Fred T. Hall.

CHAPEL HILL: *Morehead Planetarium.* University of North Carolina, Chapel Hill, N. C.

SCHEDULE: Sunday through Saturday, 8:30 p.m.; also at 11 a.m. and 3 p.m. Saturday, 3 and 4 p.m. Sunday. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: *Hillis Townsend Planetarium.* Children's Museum, Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11 a.m. Admission free. Spitz projector. Director, Mrs. R. L. Sullivan.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 2-1428.

SCHEDULE: Monday through Saturday, 11 a.m. and 3 p.m.; Tuesday and Friday, 8 p.m.; Sunday, 2 and 3:30 p.m. Zeiss projector. Director, Albert Shatzel.

DALLAS: *Dallas Planetarium.* Dallas Health Museum, Fair Park, Dallas 10, Tex., HA 8-5755.

SCHEDULE: Saturday, 10:30 a.m.; Sunday, 2:30 and 4 p.m. Spitz projector. Planetarium Educator, Mrs. Claudia Robinson.

DENVER: *Denver Museum of Natural History Planetarium.* City Park, Denver, Colo., East 2-1808.

SCHEDULE: Saturday and Sunday, 1 to 4:30 p.m. Spitz projector. Curator, W. R. Van Nattan.

FT. WORTH: *Charlie M. Noble Planetarium.* Ft. Worth Children's Museum, 1501 Montgomery St., Ft. Worth, Tex., PE 2-1461.

SCHEDULE: Tuesday through Friday, 4 p.m.; Saturday, 11 a.m. and 2:30 p.m.; Sunday, 2:30 p.m. Spitz projector. Director, William Hassler.

INDIANAPOLIS: *Holcomb Planetarium.* Butler University, Indianapolis 7, Ind.

SCHEDULE: Saturday and Sunday, 4 and 8 p.m. Spitz projector. Director, Harry E. Crull.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 23, Mo., Humboldt 3-8000.

SCHEDULE: Saturday and Sunday, 3 p.m. Spitz projector. Director, Kenneth W. Prescott.

LANCASTER, PA.: *North Museum and Planetarium.* Franklin and Marshall College, Lancaster, Pa.

SCHEDULE: Tuesday and Thursday, 8 p.m.; Saturday and Sunday, 3 p.m. Admission free. Spitz projector. Curator, John W. Price.

LAQUEY, MO.: *Tarbell Planetarium.* Inca Cave Park, Laquey, Mo.

SCHEDULE: Sunday, 1 to 6 p.m., continuous. Spitz projector. Director, E. D. Tarbell.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 27787, Los Feliz Station, Los Angeles 27, Calif., Normandy 4-1191.

SCHEDULE: Daily (except Monday and Tuesday), 8:30 p.m.; also 3 p.m. Saturday, and 3 and 4:15 p.m. Sunday. Zeiss projector. Director, Dinsmore Alter.

MINNEAPOLIS: *Science Museum.* Minneapolis Public Library, 1001 Hennepin Ave., Minneapolis 3, Minn.

SCHEDULE: Saturday, 10 a.m. and 2 p.m. Admission free. Spitz projector. Curator of education, Maxine B. Haarstick.

NASHVILLE: *Sudekum Planetarium.* Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., Chapel 2-1858.

SCHEDULE: Sunday, 2:45, 3:30, 4:15 p.m. Spitz projector. Lecturer, Sam Smith.

NEWARK: *Newark Museum Planetarium.* 49 Washington St., Newark 1, N. J., Mitchell 2-0011.

SCHEDULE: Saturday, Sunday (except first Sunday of month), and holidays, 2:30 and 3:30 p.m. Admission free. Spitz projector. Supervisor, Ray J. Stein.

NEW YORK CITY: *American Museum-Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Monday, 2 and 3:30 p.m.; Tuesday through Friday, 2, 3:30 and 8:30 p.m.; Saturday, 11 a.m., 1, 2, 3, 4, 5 and 8:30 p.m.; Sunday and holidays, 1, 2, 3, 4, 5 and 8:30 p.m. Zeiss projector. Chairman, J. M. Chamberlain.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesday through Sunday, 3 p.m.; Saturday, 11 a.m.; Saturday, Sunday, and holidays, 2 p.m.; Wednesday and Friday, 8 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 1-4300.

SCHEDULE: Monday through Friday, 2:15 and 8:30 p.m.; Saturday, 11 a.m., 2:15 and 8:30 p.m.; Sunday, 2:15, 4:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PROVIDENCE: *Roger Williams Planetarium.* Roger Williams Park Museum, Providence 5, R. I., Williams 1-5640.

SCHEDULE: Saturday, Sunday, and holidays, 3 and 4 p.m. (Oct.-June). Admission free. Spitz projector. Director, Maribelle Cormack.

SAN FRANCISCO: *Morrison Planetarium.* California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif., Bayview 1-5100.

SCHEDULE: Daily (except Monday and Tuesday), 3:30 and 8:30 p.m.; also 2 p.m. Saturday, Sunday, and holidays. Academy projector. Curator, George W. Bunton.

SAN JOSE, CALIF.: *Rosicrucian Planetarium and Science Museum.* Park Ave. and Naglee Ave., San Jose, Calif.

SCHEDULE: Sunday and Wednesday, 2 and 3:30 p.m. Spitz projector. Director, Rodman R. Clayson.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesday, Thursday, and Saturday, 3 p.m.; also 8:30 p.m. Tuesday; special star stories for children, Saturday, 2 p.m. Admission free. Korkosz projector. Director, F. Korkosz.

ASTRONOMICAL SCRAPBOOK

The Problem of Visual Observations of Venus

RECENTLY the German astronomer, Joseph Meurers, wrote a small book called *Astronomical Experiments*. It is a systematic survey of scores of different laboratory experiments intended to simulate astronomical objects and phenomena under controlled conditions.

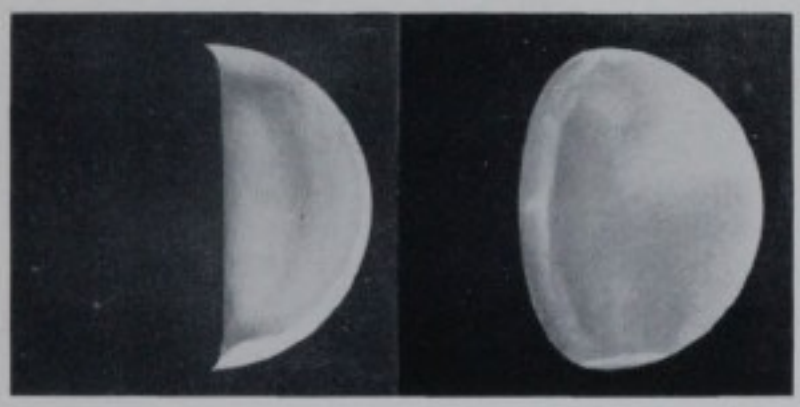
The book tells of many efforts toward the small-scale duplication of lunar craters; we read of the work of physicists at Ann Arbor and Kiel, who already can reproduce in the laboratory the conditions occurring in the atmospheres of some stars. One section deals with Dr. Meurers' own work with artificial star fields. He allows a fine mist of ink droplets to fall several feet onto a sheet of paper, thereby producing a wholly random distribution of "stars." These show close counterparts to the star chains that are sometimes so striking on Milky Way photographs. Both kinds of chains have the same statistical properties. Here is a straightforward demonstration that star chains do not in general have any special physical significance.

Experimental methods have a growing place in astronomy, and Dr. Meurers' book contains valuable hints for anyone who faces a cumbersome astronomical problem and is looking for a simpler, unorthodox approach. It is also a disturbing book, as I found on reading the pages dealing with visual observations of detail on the planet Venus. He reports experiments making plain that many of the ordinarily observed disk features on this planet may have no objective existence.

The majority of advanced observers who devote much time to viewing Venus habitually record certain features: bright caps near the cusps of the crescent, a bright band along the limb, and a shading along the terminator. In addition, darkish collars bordering the cusp caps are often seen, as well as indistinct dusky and brighter patches on the disk. All these features represent only slight differences in contrast. Other more difficult and controversial markings have been glimpsed by only a very few observers; a noteworthy example is the pattern of dark spokes radiating from the center of the disk, reported by Percival Lowell.

The preceding broad description applies well to certain drawings made at Munich Observatory in 1897 by the Swiss-born astronomer, Walter Villiger, who later was for many years chief of the astronomical division of the Carl Zeiss works in Jena. However, some Villiger drawings, three of which are at the lower right, show illuminated balls of rubber or plaster of Paris, 55 millimeters in diameter, viewed from a distance of 400 meters with a 5-inch refractor. Although each of these balls actually had a completely structureless surface, the drawings show cusp caps, bright limb bands, and the characteristic dusky patches. Note the close resemblance between these model drawings and two other sketches of the actual planet, made by Villiger with a 5½-inch aperture.

Confirmation of these disquieting results is afforded by another series of careful experiments on Venus models, carried out in 1952 by the well-known German amateur, W. W. Spangenberg. He too used smooth, featureless spheres, viewed with small telescopes at such distances that they appeared the same size as Venus observed with powers of 60x to 140x. To simulate unsteady seeing, he placed an electric heater underneath the telescope objective.



Two drawings of Venus, made by Walter Villiger with the 10½-inch Munich Observatory refractor stopped down to 5½ inches. Left: November 16, 1895, at 18:15 Greenwich mean time; right, March 21, 1896, at 21:15. From the "Annals" of Munich Observatory, 1898.

Spangenberg's drawings of his models suggest typical depictions of the planet itself. They add to the demonstration that purely illusory cusp caps and collars, limb brightenings, and dusky streaks can be recorded. Furthermore, the Villiger and Spangenberg experiments, taken together, show that independent observers may share a common pattern of optical illusions. Evidently, we are no longer always entitled to assume that a Venus feature is real simply because it has been similarly drawn by independent observers.

The serious visual observer of Venus, before he can secure wholly trustworthy results, ought to find out how to distinguish possible true features from subjective appearances. A very promising clue comes from the experience of Audouin Dollfus, of Meudon Observatory, summarized on page 397 of the July, 1956, *Sky and Telescope*. Using a number of telescopes of different apertures and with powers of 20x to 1,200x, he ascertained that the illusory markings become less conspicuous with increasing magnification. He concluded that when Venus is magnified enough to make its telescopic image six times the naked-eye diameter of the moon, spurious effects become inappreciable.

The Dollfus findings throw interesting light on the often-stated fact that Venus markings are better seen with small telescopes than large. W. F. Denning, a very experienced British planetary observer, wrote in 1891:

"Accounts are sometimes published of very dark and definite markings seen with only 2 or 3 inches aperture. Such assertions are usually unreliable. Could the authors of such statements survey the planet through a good 10- or 12-inch telescope, they would see at once they had been deceived. Some years ago I made a number of observations of Venus with 2-, 3-, and 4¼-inch refractors and 4- and 10-inch reflectors, and could readily detect with the small instruments what certainly appeared to be spots of a pronounced nature, but on appealing to the 10-inch reflector, in which the view became immensely improved, the spots quite disappeared, and there remained scarcely more than a suspicion of the faint condensations which usually constitute the only visible markings on the surface. . . ."

To this might be added the testimony of Gruithuisen, who made many observations of Venus from 1813 to 1847. He was the first to report the cusp caps, and examined them in many telescopes, but

These three Villiger sketches are of models of Venus, as seen through a 5-inch telescope. The one at the left was of a rubber ball, the others of a plaster-of-Paris globe. Since the models were featureless, the details in these drawings are entirely subjective.

he saw them best with his smallest instrument, of only 1½-inch aperture!

Because our discussion is based on the evidence of only five observers, a very small sampling, no sweeping conclusion should be drawn. But clearly it is a wise precaution for those who make visual observations of Venus to carry out analogous observations of models. In this way, the observer can find if his drawings contain subjective markings. By varying the experiments, he will be able to discover which observing techniques minimize the risk of self-deception. Visual observations of Venus secured with precautions of this sort would deserve more confidence.

Similar experimental studies might well be made by observers of surface detail on the minute disks of Uranus, Neptune, or the four large satellites of Jupiter. Spangenberg pointed out that in many of his model tests he recorded the dark central cross characteristic of the Uranus drawings of Leo Brenner.

JOSEPH ASHBROOK

Meurers' book, *Astronomische Experimente*, is in German; it was published by Akademie-Verlag, Berlin, in 1956. Villiger's own detailed report of his Venus experiments is in Volume 3 of the *Neue Annalen* of Munich Observatory, 1898. His paper includes a valuable but rather overlooked critique of all the principal Venus observations made up to that time. Spangenberg's paper was in *Astronomische Nachrichten, 281*, 6, 1952.

HAYDEN PLANETARIUM ASTRONOMY CLASSES

A combination lecture and laboratory course in making a 6-inch telescope mirror will be offered this fall in the American Museum-Hayden Planetarium's program of adult classes in astronomy, navigation, and meteorology.

Two separate classes, limited to 15 students each, will be held once a week on Tuesday and Thursday evenings, beginning October 1st and 3rd. The $40.00 course fee includes a pyrex mirror blank and all the necessary materials for grinding, polishing, and figuring. Upon its completion, the mirror becomes the property of the student.

A booklet describing all courses offered this fall and next spring may be obtained from the American Museum-Hayden Planetarium, New York 24, N. Y.

NEW YERKES-MCDONALD DIRECTOR

The University of Chicago has announced the appointment, effective September 1st, of Gerard P. Kuiper as chairman of its department of astronomy and as director of Yerkes and McDonald Observatories.

Dr. Kuiper has long been an authority on binary stars and white dwarfs. In recent years he has been active in observational studies of the planets and satellites, and in theoretical investigations of the origin and evolution of the solar system.

Amateur Astronomers

Telescope Makers Meet at Stellafane

EVENING CLOUDS and later rain covered Breezy Hill at the 1957 Stellafane convention on Saturday, August 3rd. However, the weather failed to dampen the spirits of over 300 enthusiasts who brought 25 telescopes to the annual affair at Springfield, Vermont. But serious precipitation did not fall until after 11 p.m., when the instruments had been packed away and the crowded hilltop abandoned. Nevertheless, that night about 30 parties camped in the neighboring hay field.

As usual on the morning of Stellafane, the Jones and Lamson Machine Co. opened its optical comparator division for inspection, affording visitors a chance to see how modern industry is applying optics in the precision measurement of machinery components.

A number of distinguished persons attended, including Governor Joseph Johnson and Senator Ralph Flanders of Vermont; Mrs. Margaret W. Mayall, director of the American Association of Variable Star Observers; Dr. Armand N. Spitz, co-ordinator of visual observations for MOONWATCH; and Grace C. Scholz, president of the Astronomical League.

The principal talk in the afternoon was by John Gregory, Perkin-Elmer Corp., on "The Design of Maksutov Telescope Systems." Using the recently computed design of an 11-inch Newtonian-Cassegrainian instrument as an example, Mr. Gregory pointed out the limitations and advantages of this type of telescope compared to the conventional open-tube reflector (see *Sky and Telescope*, page 236, March, and page 440, July, 1957).

The moderator of the session, Robert E. Cox, exhibited a 6-inch Maksutov blank, curve-generated and ready for fine grinding, together with an inexpensive micrometer and 6-inch vernier caliper, all for use in the construction of a Maksutov lens. Allan Mackintosh, Glen Cove, New York, showed his precision spherometer for controlling the radii of steep surfaces.

Leon Campbell, Jr., Smithsonian Astrophysical Observatory, then spoke on "Satellite Observing Instrumentation," describing telescopes, timing systems, and general MOONWATCH station procedure.

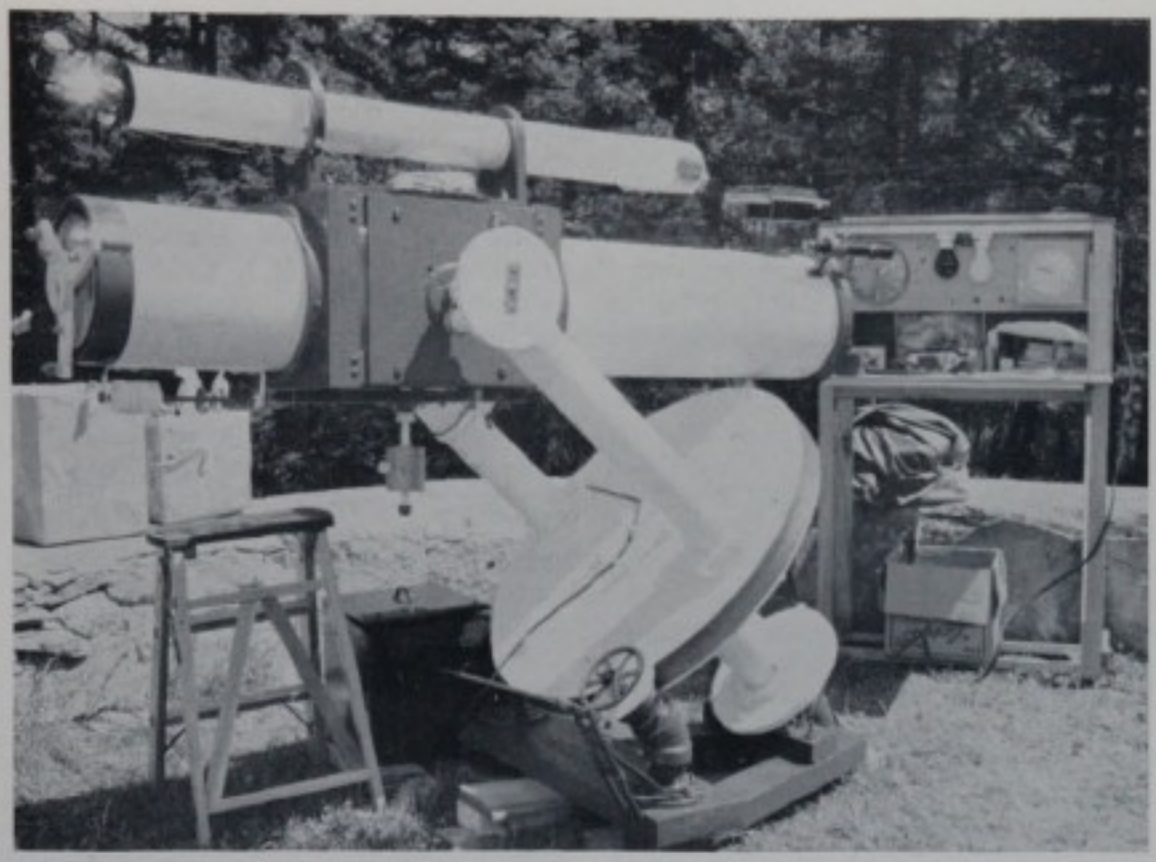
In the afternoon the telescopes were judged for mechanical excellence on the basis of 20 points for ruggedness, 15 points for convenience, and 25 points for ingenuity. (Evening clouds prevented the judging of optical excellence.)

First prize went to 18-year-old Berton C. Willard, Charlestown, New Hampshire, for his 8-inch f/8 Newtonian reflector. Two years were spent constructing the instrument, which includes a complete console unit incorporating timing clocks and a work table, all built without machine tools. This rugged telescope has motor drives on both axes and a push-button correction drive in right ascension for use when guiding during photographic exposures.

Second prize was won by D. W. Cogswell, West Springfield, Massachusetts, for a 4-inch f/8 reflector with fork mounting, and third prize was awarded to Frank Torney, Weymouth, Massachusetts, for his 8-inch f/10 reflector and its piggyback-mounted 4-inch Newtonian.

Awards were also made for the best wide-angle telescope, to Jerry Burns,

Part of the audience at Stellafane, as Walter J. Semerau, of Kenmore, New York, presented slides of his photographs of solar prominences.



Berton C. Willard's 8-inch reflector won first prize. A counterweight beneath the main tube balances the long guiding telescope mounted on top. In the right background is the well-equipped control console. Stellafane photographs by Robert E. Cox.

Philadelphia, Pennsylvania; best in photographic work, Peter A. Wehinger, Goshen, New York; and best effort by a young exhibitor, John Sanford, Newburgh, New York. For exhibits other than telescopes, special prizes were made for a homemade microscope, a photographic exhibit of the construction of a 12-inch Cassegrainian, and a homemade sidereal clock.

The evening program, conducted by Dr. Charles H. Smiley, Ladd Observatory, started with welcoming talks by Governor Johnson and Senator Flanders, both former telescope makers in the Springfield club. Dr. Spitz discussed especially the problems of organizing flybys of simulated satellites for the practice sessions of the amateur observing stations.

Another Springfield amateur, Mrs. Margaret Beardsley, stressed the importance of using amateur telescopes for regular observing, followed with regular reports to such groups as the AAVSO. Walter J. Semerau, Kenmore, New York, spoke on the construction of a solar coronagraph and a spectroheliograph. He showed photographs of amazingly intricate prominences on the sun, taken in hydrogen light. He has completed an electronic automatic guiding system to keep the coronagraph pointed at the sun.

Color movies of earlier Stellafane meetings, picturing Russell W. Porter and many of the old-time telescope makers, were shown by a Springfield amateur, Ernest Flanders.

RALPH K. DAKIN and
GEORGE T. KEENE
Astronomy Section
Rochester Academy of Science
Rochester, N. Y.

Notable among the Stellafane exhibits was this reflector, with a hexagonal wooden tube, an alarm-clock drive, and adapters for photography. It was made by Albert Nagler, New York City.

AAVSO FALL MEETING

The annual fall meeting of the American Association of Variable Star Observers will be held on Friday and Saturday, October 4-5, at Amherst College Observatory, Amherst, Massachusetts. Nonmembers are invited to attend the sessions, which cover a wide range of topics of interest to amateur astronomers. Additional information can be obtained from the director, Mrs. Margaret W. Mayall, 4 Brattle St., Cambridge 38, Mass.

THIS MONTH'S MEETINGS

Detroit, Mich.: Detroit Astronomical Society, 2:30 p.m., State Hall, Wayne University. Oct. 13, Lovell Lawrence, Jr., "Past, Present, and Future of Rocketry."

Madison, Wisc.: Madison Astronomical Society, 8 p.m., Washburn Observatory. Oct. 9, William Binney, "Telescopes and Telescope Making."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. Oct. 5, Dr. James C. Bartlett, Jr., "Planetary Observations."

TELESCOPE MAKING CLASSES IN CLEVELAND

A course in the construction of reflecting telescopes is being conducted by the Cleveland Amateur Telescope Makers, a group sponsored by the Cleveland Astronomical Society and the Cleveland Museum of Natural History. The classes are held on Tuesdays, from 6 to 9 p.m., at the planetarium building of the museum, 2717 Euclid Ave. They will run throughout the winter, in order to give each student plenty of time to finish his instrument.

Conventional 6-inch Newtonian telescopes, equatorially mounted, with powers up to 200x, have been made in this class in past years. The course fee includes the mirror blank and tool, abrasives, and optical materials, while castings and other mounting parts are furnished at cost. All the necessary tools, machines, and testing equipment are available in the workshop. The volunteer staff of instructors is directed by James L. Russell and John R. Faloon.

NORTHWEST CONVENTION

About 60 amateurs attended the 10th annual convention of the Northwest Region of the Astronomical League, which was held at Gonzaga University, Spokane, Washington, on July 27-28. The Amateur Telescope Makers of Spokane was the host society.

The program featured an address by Dr. H. Ward Crowley, University of Idaho, on colliding galaxies and radio astronomy. There was a showing of two motion pictures about the moon, produced by amateur astronomers of Jacksonville, Florida, the second film depicting the November 18, 1956, total eclipse by means of time-lapse photography. Howard Thomas, Coulee Dam, Washington, demonstrated how to make a pitch lap.

Elected as regional officers were Richard Caputo, Spokane, chairman; Mr. Thomas, vice-chairman; Mrs. Margaret E. Kobs, Portland, Oregon, recording secretary; Mrs. Rose A. Brophy, Spokane, treasurer; Norman C. Dalke, Seattle, executive secretary; and Edward J. Newman, Yakima, Washington, national council representative.

Sky and TELESCOPE

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BOOKS AND THE SKY

THE MODERN UNIVERSE

Raymond A. Lyttleton. Harper and Brothers, New York, 1956. 207 pages. $3.50.

WELL KNOWN to astronomers for several books and his original research work, Dr. Lyttleton has written *The Modern Universe* as his first elementary book. Intended as a brief popular account of astronomy, it was expanded from a series of six television programs the author gave in Great Britain, and shows the imprint of his earlier writings in both content and style.

Six chapters, each with a short bibliography, concern the earth, the moon, planets and comets, the sun, stars and the galaxy, and the expanding universe.

The book has an attractive cover and page format, but no index. It is illustrated with numerous drawings, and at the center has 16 pages of photographs, aptly chosen and well reproduced. I regret that expense has prevented the collation of photographs with text material, in this as in so many recently published books.

The organization within chapters is weak, and Dr. Lyttleton's style is indirect, with many long, involved sentences. He often employs useful expressions and analogies to describe scientific terms and concepts, but sometimes his devices may puzzle the layman. On page 153 he says that information which depends on stellar parallax can be directly obtained for only the nearest stars. From these we infer the properties of stars throughout the galaxy, "as though, say, five thousand people were selected more or less at random from all over the world; a study of these would give fairly reliable evidence about people as a whole." It would be more realistic to say "five thousand people *from one town*."

Some misstatements need correction: Sunspots are called "disturbances," but their umbrae are really quiet regions in an otherwise stormy, turbulent atmosphere (page 122). Jupiter does not have an enormously deep atmosphere, for R. Wildt and W. DeMarcus have shown it to be only a few hundred miles thick (page 90). Stars in binary systems are not necessarily similar to single stars in radius, luminosity, *and mass;* in comparison with binary stars, even the sun is 0.6 magnitude too bright for its mass (page 161). The Small Magellanic Cloud is not nearer to us than the Large Magellanic Cloud (page 152).

The author describes several possible rearrangements that may have taken place in our planetary system since its inception, such as that Pluto and Mercury may be escaped satellites of other planets, and that some planets' moons may be captured asteroids. Studies now in progress, especially by E. Rabe, on the motions of satellites of a planet with changing mass, may test these hypotheses.

Interesting discussions of several topics of which Dr. Lyttleton has made special studies are included: the origin of the earth's magnetic field, solar coronal phenomena explained by incoming interstellar matter, the formation of heavy elements in supernovae, and the continuous creation theory. His treatment of the formation of comets is based on his book, *The Comets and Their Origin*, reviewed in *Sky and Telescope*, page 20, November, 1953. He pictures the solar system as a by-product of a companion star to the sun which became a supernova, but there is unfortunately no reference to the important theory originated by C. F. von Weizsäcker.

A useful table of planetary data appears on page 100, but requires changes and additions. In 1955, R. L. Duncombe revised the mass of Mercury upward, so its mean density becomes 5.7 ± 0.4 times that of water—possibly greater than the earth's density. G. P. Kuiper's observations of cloud bands in the atmosphere of Venus a few years ago suggest that the inclination of the planet's equator to its orbit is about 32 degrees. The known diameter of Neptune has been reduced to 28,000 miles, which raises the planet's mean density to

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2.2 times water, and also lowers the spectroscopic value for its rotation period from 15.8 to 14.1 hours. The rotation period of the asteroid Ceres has now been measured photoelectrically as nine hours, five minutes.

CHARLES GASTEYER
Van Vleck Observatory
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REALITIES OF SPACE TRAVEL

L. J. Carter, editor. Putnam and Company, Ltd., 42 Great Russell St., London W.C. 1, England, 1957. 431 pages. £1, 15s.

READERS of this magazine by now are well acquainted with popular expositions of the practical problems of interplanetary flight. Here are collected 24 articles presented to the British Interplanetary Society that give the experts' views on these many problems, mainly in technical language.

For that reason most of the chapters will offer rather difficult reading for anyone not familiar with the terminology and procedures of celestial mechanics, astroballistics, and aerodynamics. Notwithstanding this aspect of the collection, which recommends it highly as supplementary reading for an undergraduate course in dynamical astronomy, the presentation is uniformly clear and intelligible.

The book systematically covers almost every conceivable aspect of the tasks of safely transporting and recovering manned as well as unmanned vehicles to an artificial satellite orbit, to the moon, and to Mars. A sampling of the contents indicates the scope and depth of treatment: A. C. Clarke, "The Dynamics of Space Flight"; T. Nonweiler, "Descent from Satellite Orbits Using Aerodynamic Braking"; W. N. Neat, "Some Limiting Factors of Chemical Rocket Motors"; M. W. Ovenden, "Meteor Hazards to Space Stations"; N. J. Bowman, "The Food and Atmosphere Control Problem."

Each author has first recognized clearly the technical obstacles we now face in each particular phase of space travel, and he then has assessed the proposed means of solving these problems. The outstanding merit of this book is that it fulfills its promise of discussing realities. One is not asked to accept solutions as feasible that are merely plausible suggestions made less unpalatable only by the aid of beautiful paintings! Nevertheless, most of the experts are confident that in their fields no insurmountable difficulties exist, and that space travel appears as certain of achievement as, say, supersonic aerodynamic flight appeared 15 years ago.

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immediate development to provide the acceleration needed to establish an artificial satellite. To be sure, the mass ratios (pay load divided by dead weight of fuel and motors) would be stupendously extravagant for interplanetary flight using present-day propellants. For that reason, several authors discuss at length atomic-powered rockets and ion-gun vehicles powered by radiant solar energy. While no such engines have been built, their principles are understood well enough to promise successful development when the need of them is urgent.

Only when we consider the control and habitability problems of interplanetary travel do serious doubts appear. Human beings *may* not be able to continue normal sensory and motor functions in zero gravity. Cosmic radiation is *likely* to produce very adverse effects on a human being during prolonged exposure outside an atmosphere. And meteor collisions are held to be a very real hazard. Space travel will indeed be a sporting affair.

HENRY J. SMITH
Sacramento Peak Observatory

NEW BOOKS RECEIVED

THE AMERICAN NAUTICAL ALMANAC FOR THE YEAR 1958, *Nautical Almanac Office,* U. S. Naval Observatory, 1956, *U. S. Government Printing Office,* Washington 25, D. C. 276 pages. $2.00.

THE ABRIDGED NAUTICAL ALMANAC FOR THE YEAR 1958, *H. M. Nautical Almanac Office,* Royal Greenwich Observatory, 1956, *H. M. Stationery Office,* York House, Kingsway, London W. C. 2, England. 276 pages. 15s.

Beginning with this volume, these handbooks for navigators become identical in content, produced under the joint supervision of the U. S. Naval Observatory and the Royal Greenwich Observatory, but printed separately in the United States and Great Britain. Revised to meet the requirements of both the U. S. Navy and the British Admiralty, the almanacs are changed little except in arrangement.

These publications should not be confused with the larger and higher priced *American Ephemeris and Nautical Almanac* and British *Nautical Almanac and Astronomical Ephemeris,* which contain much astronomical data not needed by navigators.

ROCKETS, MISSILES, AND SPACE TRAVEL, *Willy Ley,* 1957, *Viking.* 528 pages. $6.75.

Newly released information on rockets and space travel, including the artificial satellite and other developments, has been added to this enlarged third revision. The book includes descriptions of war rockets that were still secret at the time of the previous printing in 1951. The greatly expanded bibliography lists recently declassified government publications and books from other countries including Russia.

CARTOGRAPHY, *Hubert A. Bauer,* 1957, *Bellman Publishing Co.,* Box 172, Cambridge 38, Mass. 32 pages. $1.00, paper bound.

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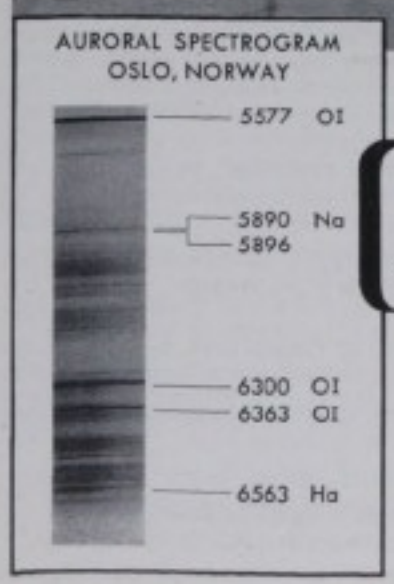
Dr. D. K. Berkey, Dept. of Physics and Astronomy, Colgate University, uses spectrograph built around B&L grating to record auroral spectra (left) in Oslo, Norway.



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THE OXIDATION AND WEATHERING OF METEORITES, *John Davis Buddhue*, 1957, *University of New Mexico Press*. 161 pages. $1.75.

The monograph, No. 3 of the University of New Mexico *Publications in Meteoritics*, analyzes meteorites from all parts of the world to explain why such objects have not been found in older rocks. The detailed bibliography lists 225 titles.

A KEY TO THE STARS, *R. van der Riet Woolley*, 1957, *Philosophical Library*. 144 pages. $4.75.

This is the third edition of a popular account written 20 years ago of the work of astronomers and what they have found about the universe. The author is now the Astronomer Royal of England.

THE AMATEUR ASTRONOMER, *Patrick Moore*, 1957, *Norton*. 337 pages. $4.50.

This simply written book is aimed at the needs of the beginner who wishes to make an active start in astronomy with modest equipment.

CONCEPTS OF FORCE, *Max Jammer*, 1957, *Harvard University Press*. 269 pages. $5.50.

This historical analysis of the concept of force in present-day physics is intended not only for the professional physicist and the historian of science but for the philosophically minded reader interested in basic scientific problems.

THE COPERNICAN REVOLUTION, *Thomas S. Kuhn*, 1957, *Harvard University Press*. 297 pages. $5.50.

The author traces in detail the supplanting of the ancient geocentric concept of the solar system by the ideas of Copernicus. The Copernican revolution is used as a case history to illustrate the development of western thought.

LIGHT SCATTERING BY SMALL PARTICLES, *H. C. van de Hulst*, 1957, *Wiley*. 470 pages. $12.00.

A well-known Dutch astronomer has provided researchers with comprehensive methods for solving problems on the scattering of electromagnetic waves by a sphere. Several related subjects, such as scattering by cylinders, have been added to his original topic. Specific applications are given for the fields of chemistry, meteorology, and astronomy. This book is one of the publisher's series on the structure of matter.

PHYSICAL SCIENCE FOR LIBERAL ARTS STUDENTS, *Hugo N. Swenson* and *J. Edmund Woods*, 1957, *Wiley*. 333 pages. $6.50.

The aim of this college text is to give liberal arts students an insight into scientific method as applied in astronomy, chemistry, and physics, as well as some historical perspective.

THE LIFE OF ARTHUR STANLEY EDDINGTON, *A. Vibert Douglas*, 1957, *Thomas Nelson and Sons*. 207 pages. $6.25.

This biography of the English astronomer, Sir Arthur Eddington, was written at the request of his sister and with the aid of his personal papers and letters. His remarkable contributions to astronomy, physics, and philosophy are summarized. A bibliography lists all of Eddington's published scientific writings up to his death in 1944.

DISCOVERY OF THE UNIVERSE, *Gérard de Vaucouleurs*, 1957, *Macmillan*. 328 pages. $6.00.

The author has translated into English the original 1951 French version of his popular history of astronomy (*Sky and Telescope*, March, 1952, page 121), and has expanded it to include the latest developments, including radio astronomy.

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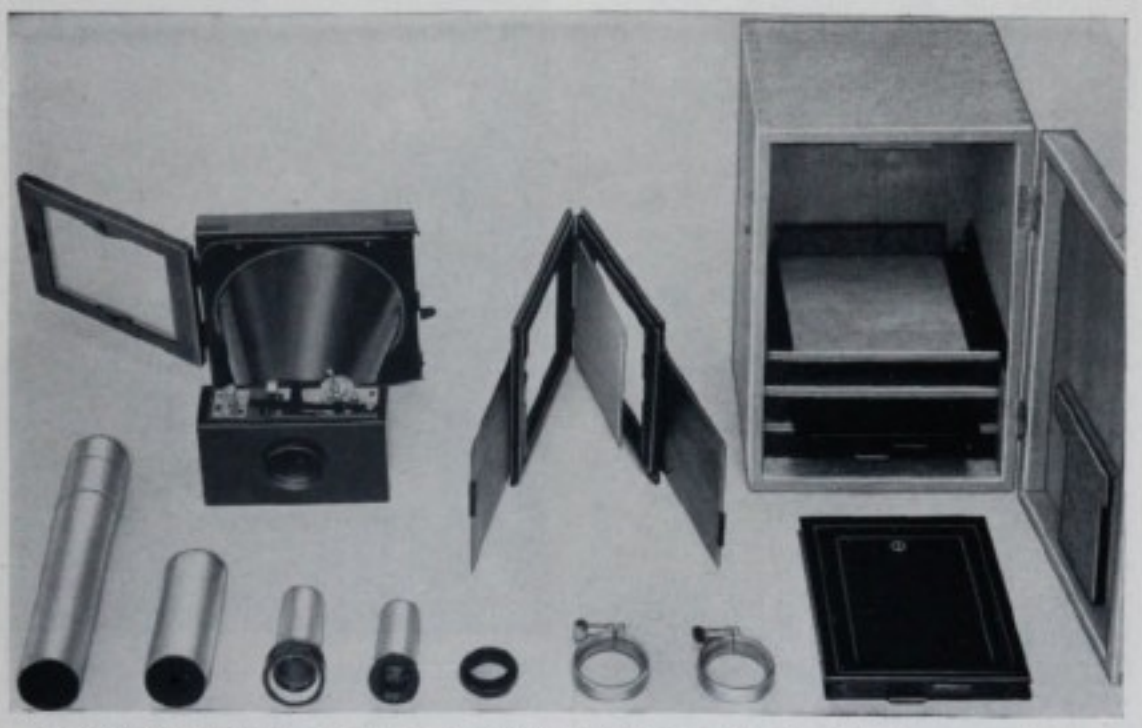

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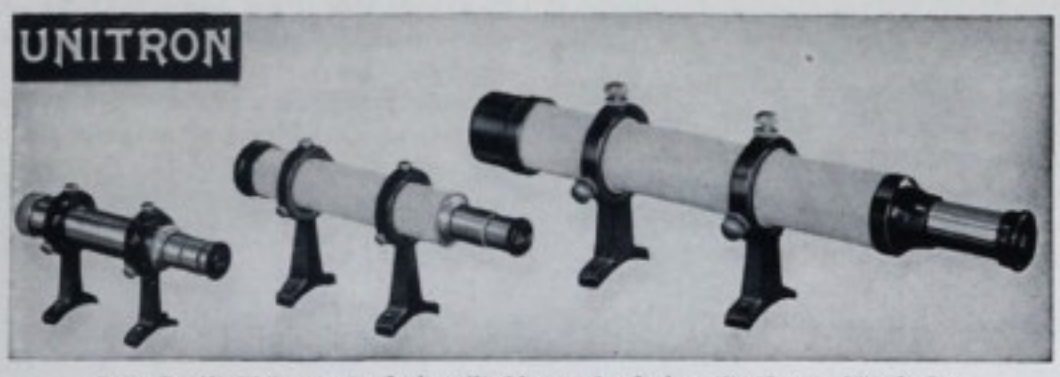

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Some Amateur Mountings of Special Interest

OPPORTUNITY for an amateur telescope maker to show his ingenuity comes when he designs and constructs the mounting of his homemade telescope. The three rather different mountings described here perform well, but differ greatly in cost and labor. Only a few holes had to be drilled and tapped on the simplest one, while welding and some machine work were necessary on the elaborate assembly of the 8-inch instrument.

Illustrated first is the very simple but efficient design by H. A. Miloche, 615 Standish Rd., Teaneck, N. J. His 6-inch mirror was ground and figured at the telescope making class of the Amateur Astronomers Association, at the Hayden Planetarium, New York City. Several instructors there have recommended this mounting to class members who wish an easy-to-make model at minimum cost.

The tripod is so simple it can be assembled in a few minutes. Unlike some other pipe-fitting designs in which 45-degree wye elements are used, it can be made to fit the observer's latitude precisely; the polar-axis angle is set by the length of the two short legs. These legs are of 1" pipe, while the polar axis consists of two pieces of 2" pipe, two reducing tees, and one 2" nipple between the tees.

The cradle, illustrated separately, was made from ¾" plywood, and turns on a declination axis consisting of reducing bushings running in the end threads of a 2" tee. The side branch of this tee screws onto the top end of the polar axle. All moving pipe threads have been run in with carborundum and oil to permit smooth operation—half a turn is all the movement required on either the polar or declination axles. The tube is held to the cradle with rubber tubing. Note that one set of counterweights balances the instrument on both axes.

This view of the saddle of Mr. Miloche's mounting shows the pipe fitting for turning the telescope in declination, and the well-designed twin counterweights.

Ease of construction and low cost are features of the mounting H. A. Miloche made for his 6-inch Newtonian reflector. Note that the south tripod foot has been cut diagonally so that its bottom is horizontal, giving larger contact with the ground and increasing the stability of the mounting.

This kind of mounting is sometimes known as a "modified fork," but, while like a fork mounting in some ways, it requires no long, rigid arms. However, the upper part of the polar axle must be long enough, the rearward overhang of the tube restricted, and the counterweights kept short enough to allow pointing the telescope to any part of the sky without striking the tripod legs. Mr. Miloche has found his design to be sturdy and free from vibration.

Lewis Acker, a 17-year-old member of the National Capital Astronomers, made his 8-inch f/8.5 mirror under the direction of Hoy Walls. He chose the cross-axis type of mounting, for it has the important advantage over German-type mountings that the telescope does not have to be reversed when it reaches the meridian. Thus uninterrupted observations and long photographic exposures are more practical with his mounting.

The working plans for the mounting were drawn up by an engineer at the Arlington Iron Works. The triangular base of the welded mounting is of 3" x 3" x ¼" angle iron, and two upright posts are braced by 2" x 2" x ¼" angle irons. At the top of each post are welded 6" x 12" x ⅜" plates at an angle equal to Washington's latitude, 39°. Material and labor for this framework cost $65, the whole mounting $154.

Under the corners of the triangular

base are casters which allow easy wheeling of the 320-pound instrument from the garage where it is stored to any convenient observing location. The three caster wheels, which cost less than $5 each, provide a secure support on uneven ground.

The polar axle is a solid shaft of cold-rolled steel, 2″ in diameter and 5′ 6″ long, costing $18. Such shafts are available in many sizes at machine shops. This axle is supported at each end in self-aligning ball-bearing pillow blocks, obtained for $11 each. They may be bolted to the two plates on top of the upright posts without shimming and still be in excellent alignment.

At a large hardware store Mr. Acker bought an 11-inch "Lazy Susan" turntable for $4.50, to use as the moving part of the declination assembly. It has take-up springs that prevent vibration and supply friction. Four rivets on its edge bolt the turntable to a 2″-thick oak block, to which is attached a heavy pipe flange. On the other side of the turntable is fastened the cradle for the telescope, a piece of oak 2″ x 10¼″ x 19″. The telescope tube is held on the cradle by four 6″ right-angle brackets.

The flange on the underside of the wooden block holding the "Lazy Susan" is connected, through a heavy pipe nipple, to a 2″ cross fitting (double tee) on the polar axle. A 2″ pipe nipple, 6″ long, was sawed in half, and each piece was screwed into an end of the cross fitting. This assembly was slipped onto the polar axle shaft, which the pipe fitted rather snugly, and shifted along the shaft to the position where the telescope could be turned to any part of the sky without the ends of its tube striking the mounting frame. Ten set screws in ¼″ tapped holes hold the cross fitting firmly to the shaft.

The counterweight consists of two 10-pound bar-bell weights, which cost about $2.50 each. They are attached to the fourth opening of the cross fitting by two long nipples and a reducer coupling.

Because the available tube was a little too short for the 68″ focal length of the 8-inch mirror, a stiff piece of steel was bolted to the upper end of the tube. This carries the single-arm spider and the eyepiece holder, but to prevent dewing of these parts it would be better to extend the main tube several inches.

Amateurs visiting in the Washington, D. C., area are invited to visit Mr. Acker in his home at 5501 Potomac Ave. N. W.

Three years went into mirror fabrication and mounting construction of the 6-inch f/9.5 Newtonian reflector of Richard C. Booth, 1755 Newton St., Akron, Ohio. Before work on the tube and equatorial mounting was started, the entire instrument was drawn to scale, six sheets of 22-by-30 drawing paper being required to show all details. Welding and some machining provided a very rugged mounting weighing 195 pounds. As Mr. Booth is a sheet-metal worker and could obtain materials at cost, only $110 was needed to make the complete instrument.

The base is a 30″ cone of 16-gauge black iron, its bottom section crimped for added strength. Notches were cut from the east and west sides so that the telescope tube could be pointed near the zenith. Under the base are three 2″ pads, with leveling screws, to prevent sinkage into soft ground.

Inside the bottom of the cone is welded a horizontal metal disk 30″ in diameter, whose center carries a cup 4″ across and 2″ deep. This provides a well into which slips the lower end of the standpipe (white

Lewis Acker stands beside his simple cross-axis mounting. The telescope is an 8-inch reflector, so placed in the saddle that proper balance is achieved. This style of mounting permits continuous observation through the zenith, which is not possible with an ordinary German-type mounting.

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R. C. Booth and his portable 6-inch reflector. The base cone is indented on its east and west sides to permit pointing the telescope at the zenith, as seen here, without striking the pier.

in the picture) that supports the equatorial head. The standpipe is held vertical by three bolts in a collar that is welded to the top of the cone. But the weight of the telescope is carried by the collar and the entire base, not by the cup in the base, which serves only as a guide.

The heaviest part of Mr. Booth's telescope is the equatorial head. Six pieces of ⅛" black iron were welded together to form its base. The bottom of the equatorial base section has a 1" flange, which is bolted to the top of the standpipe.

Each axle has an outer housing of 4" heavy-gauge pipe, capped at both ends by steel plates with central holes to carry heavy-gauge 2" pipe, welded in place. Mr. Booth took these assemblies to a machine shop to have the inner pipes bored out to the proper size to receive the bearings. These are flange-type oil-impregnated bearings, which were honed out on a drill press until the axles could just slip through.

Both the right ascension and declination axles are cadmium-plated 1⅝" cold-rolled steel bars, each with a smaller shaft attached to its lower end to carry the counterweights. These are of lead, cast into square aluminum boxes with convenient carrying handles.

Bronze collars around the shafts keep them from slipping from their housings. Each axle has a brake shoe consisting of stainless steel rolled to a half circle, with rubber cemented to the inner surface. These clamps are operated by wing bolts extending out through the housings, and any desired degree of turning friction is easily obtained.

The saddle for the telescope tube is of 16-gauge black iron, lined with billiard-table cloth. Two straps of the same metal are attached by hinges to the saddle and are secured with trunk latches.

For ease of transportation, Mr. Booth has made his tube in two parts, each with its own carrying case. The tube is of 16-gauge black iron, welded on the inside. To assure straightness of the assembled tube, a sleeve extends 2" from the bottom of the upper half into the lower half. To draw the halves snugly together, three trunk latches were installed so that when each is closed a definite snap can be heard, indicating the tightness of the joint. A pin and slot provide proper orientation of the optical parts when the tube halves are fitted together.

The mirror is held in a mahogany cell, which is supported by a metal container attached to the telescope tube. This arrangement helps insulate the mirror from rapid temperature changes. Bolts and spring-loaded nuts provide amply for mirror alignment. The upper end of the telescope tube contains a homemade aluminum rack-and-pinion focusing device, and a one-legged spider of 16-gauge stainless steel to support the prism.

Before assembling his instrument, Mr. Booth sandblasted the parts that were to be painted, for better adhesion of the paint; other parts were cadmium plated to prevent rusting. He has made setting circles, and plans to add a hand-operated slow-motion drive.

The Booth telescope has been disassembled to show, left to right, the base cone, standpipe, equatorial head and saddle, and the two tube sections, with the mirror cell lying between them. The parts can all be easily transported in an auto.

ON THE PROBLEM OF CHOOSING A TELESCOPE

The choosing of a personal telescope nowadays must be very difficult for any newcomer to the field of astronomy. Thirty years ago when we ourselves became amateurs there was not any "Sky and Telescope" magazine to bedazzle our eyes every month with its host of instrumental offerings for every purse and purpose. Back in those practically prehistoric times you could arrange to have a refractor custom-built at home or abroad, or you could make yourself a reflector if you had heard of the wonderful new book just published by the now legendary A. G. Ingalls, called "Amateur Telescope Making." Since there were almost no war-surplus items, a great many of us got our first glimpses of the sky through some battered spyglass from a dusty pawnshop.

Today your choice is wide indeed, but choosing is not easy. Should it be a reflector or refractor? Should you buy a lot of aperture and skimp on mounting, or vice versa? Should you make part of it yourself? Should it be portable, semiportable, or a permanent job with some sort of shelter? How big ought the doggone thing to be? What power should it have, and how many eyepieces? Above all, since everybody says his telescope is wonderful, whom can you believe, and what size and make are really the best?

We'd like to talk about size of aperture this month. As you know, the larger the aperture, the smaller the diffraction image, and the greater the resolving power. Theory says so, and controlled laboratory tests confirm it for all optical systems of requisite quality. Thus one may test a large lens or mirror in the laboratory and secure wonderful resolution, only to mount it and have it prove most disappointing on the sky itself if seeing conditions are not right. Until quite recently, little thought had been given to improving the inherent defects of the conventional 18th century refracting and reflecting telescopes.

It took 50 years for the simple reflector of Newton, and the compound ones of Cassegrain and Gregory, to come into use, and about a century to perfect the so-called achromatic lens. At the turn of the 20th century, the catadioptric or mixed-lens-and-mirror systems of Goerz and Schupmann wholly escaped the notice of astronomers, while as late as 1930 Bernhard Schmidt's invaluable telescope was invented but went begging for many years. Then in 1944 Maksutov's classic paper on the all-spherical catadioptric systems appeared in the "Journal" of the Optical Society of America, but created no noticeable astronomical furor.

In 1946, feeling that something important to astronomers everywhere should not be overlooked, the Questar project was embarked upon. Eight years and a quarter-million dollars later the first Questar telescope was sold from our announcement in the June, 1954, issue of "Sky and Telescope." At one stroke the wonderful new catadioptric optics were introduced in an 89-mm. photovisual form, and for the first time a compound telescope was in regular production, with the only f/2 Cassegrain design of which we know.

Without going into the myriad improvements and elegances of this delightfully compact new instrument, we were much impressed by the better-than-theoretical performance of our little artifact. As public acceptance grew, others also discovered that nature indeed seems to favor the superfine small aperture. The series of lunar photographs taken with their Questar by the Davises of Florida, who last December were absolute novices at this sort of thing, not only astounded us, but, we are told, quite astonished the astrophotographic experts at Eastman Kodak Research Laboratories.

As the returns gradually reach us from Questar owners everywhere, in far places and from several continents, it seems that their experience with the superfine Questar's 3½-inch aperture is often similar. The new Questar optics in their short, closed 8-inch tube seem able to pierce poor seeing like a keen rapier, giving a respectable image in seeing so poor as to cripple larger apertures severely, and in fine seeing are reported as nearly equaling the performance of perfect 6-inch refractors and 8-inch reflectors. This sounds like such a whopping claim that we are glad only to be passing on what people tell us. To what extent the unrivaled observing comfort of Questar contributes is hard to say, but it is probably considerable.

A typical experience is that of Mr. M, who is executive vice-president of a large corporation, and who purchased his first Questar in July, 1954. We thought you'd like to read two letters from him in our files, which we publish with his permission.

"I expect you will remember me as one of the earlier purchasers of Questar. . . . I was a novice at astronomy at that time although experienced with many types of optical instruments.

"About a year ago I got all fired up with enthusiasm and ambition and decided that my Questar was not sufficient for my needs"—I had to have something bigger and better. Consequently, I purchased a 4-inch refractor (which didn't do a thing that Questar couldn't do better and besides was a major project to set up and use), disposed of this, and now own a very good 8-inch reflector.

"My Questar had been admired by Dr. X, professor of astronomy at the college here, so in a rash moment I presented it to the school. I do not regret this because it is now being used in the best possible manner, but I miss it. After having experience with the larger instruments I now fully appreciate the importance of Questar's ease of operation. I also know that although in theory these larger scopes should outperform Questar, in practice they don't always do it. In fact, I am wondering if the larger instruments are really worth it to the average amateur. In September I had a chance to view Mars through a large observatory telescope and at the same time compare it with a 5-inch refractor. To me there was not a nickel's worth of difference, and Dr. X himself spent most of his time at the 5-inch. Of course, I realize there is no substitute for aperture when it comes to viewing and photographing the far-distant and faint objects," but as I see it, there is not much useful or interesting work that an amateur can do in that field anyway."

(This letter ended with shipping instructions for another Questar, receipt of which Mr. M acknowledged Nov. 26, 1956, saying, "The weather here is poor now . . . I have learned never to judge performance on one night's viewing.")

Later, on June 15, 1957, we received the following letter from him:

"Just a note to tell you what excellent results I obtained in observing last night. Although the moon was full, it was one of the best nights for seeing in my experience.

"At 160 power, Cassini's division in the rings of Saturn was plainly visible, as was the apparent shadow of the rings on the surface of the planet itself. Two of Jupiter's bands were quite prominent, with an occasional suggestion of a third. When I switched to my 8-inch reflector, I found that very little more detail on either of the planets could be observed.

"At approximately midnight, when Lyra was approaching the zenith, I obtained the most perfect split of the Epsilon Lyrae pairs that I have ever observed with any instrument. Although this separation of about 2 seconds is well over Questar's theoretical limit of approximately 1.3 seconds, I was most gratified, since in my experience it is most difficult ever to utilize an instrument's theoretical limit."

This is another moon picture by a Questar owner, showing the south central portion of the moon's disk, in the region of Mare Nubium. The prominent crater near top center is Tycho, with its central mountain.

The list of Questar owners is now a most impressive one. Many government agencies beside the armed services are represented, as are industrial users such as Corning Glass and Sperry Gyroscope. Men and women in all walks of life are Questar owners, and many of them are quite distinguished persons. Some teachers of astronomy at schools, colleges, and universities are finding Questar so rewarding in a number of ways that their large instruments are only used when unusually fine seeing justifies the inconvenience.

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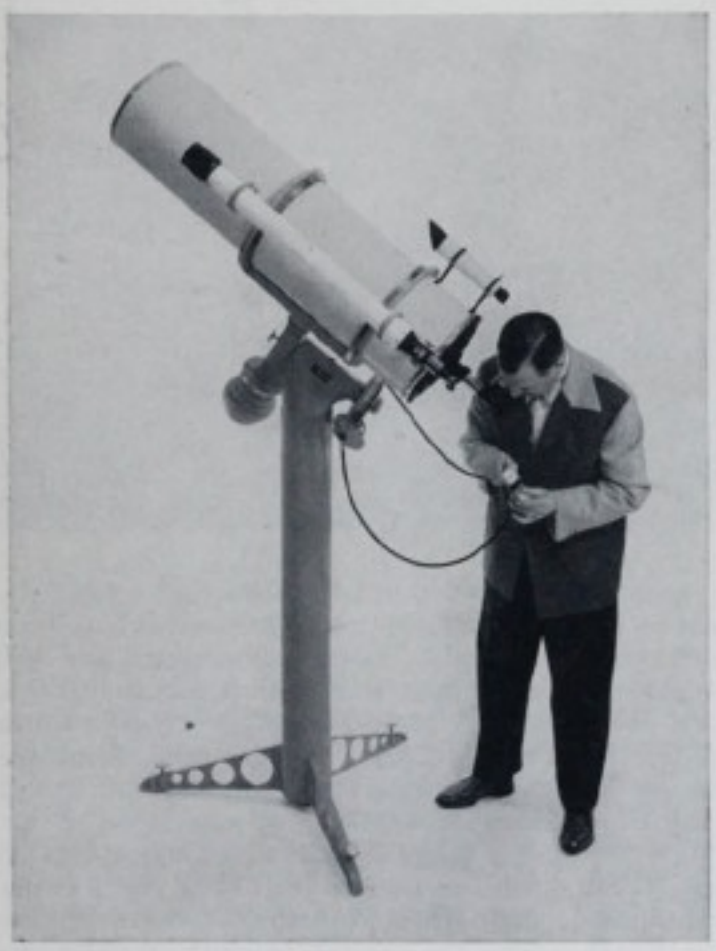

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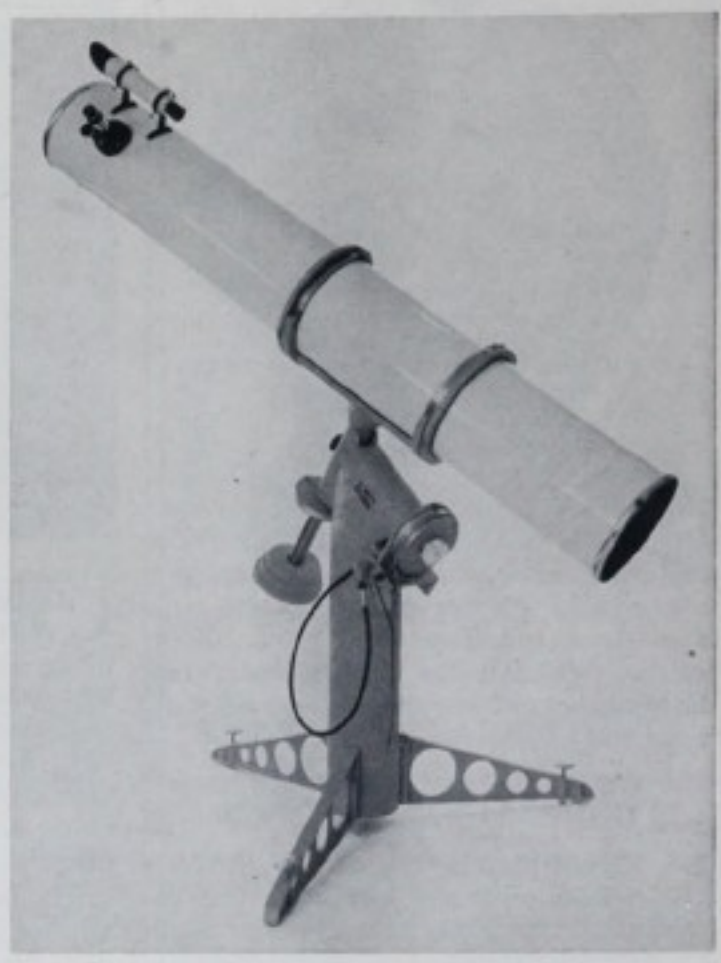

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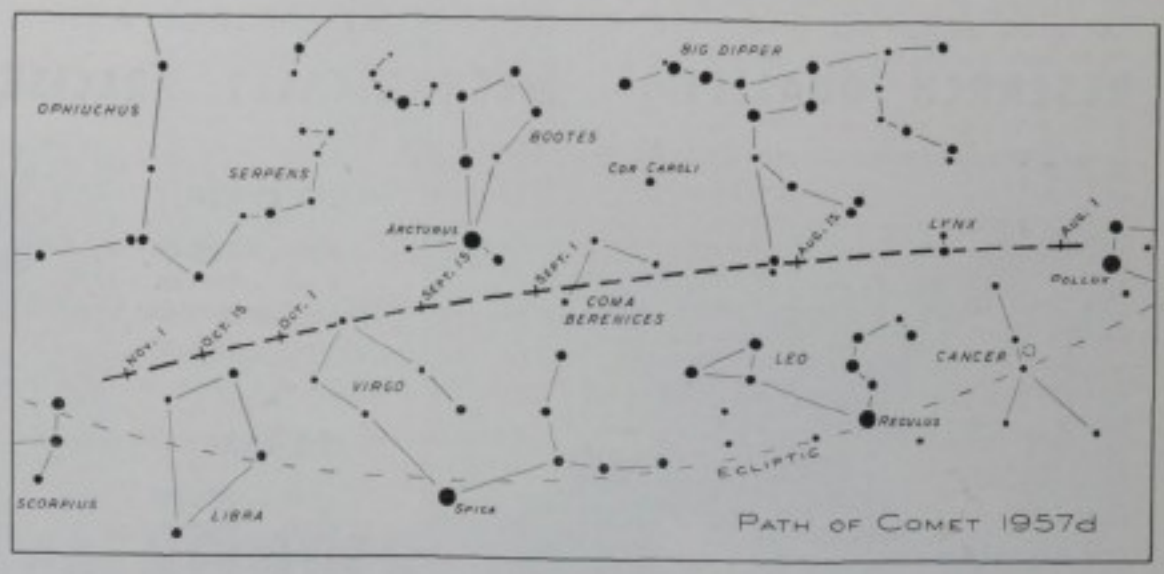
OBSERVER'S PAGE

Universal time is used unless otherwise noted.



The course of Comet Mrkos among the constellations.

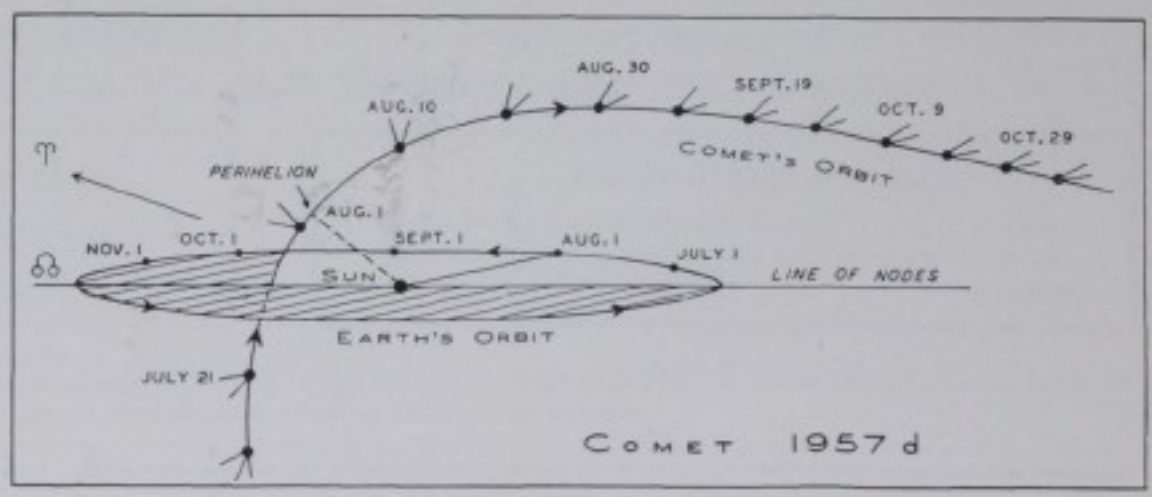
THE PATH OF COMET 1957D

COMET MRKOS, which was so conspicuous a sight during August evenings, will have faded to telescopic visibility by October. Amateurs may see it with moderate-sized instruments in the southwestern sky after evening twilight. Toward the end of the month, however, the object will be lost to view because of its nearness in the sky to the sun.

The best available information on the orbit of Comet 1957d comes from calculations by M. P. Candy, of the British Astronomical Association, reported in *Circular* No. 1615 of the International Astronomical Union. Mr. Candy's orbit was based on 19 positions measured in the first half of August, and combined into three normal places. He began by assuming that the comet's path around the sun is a parabola, an assumption which he could test by finding how closely the middle normal place could be represented by his set of orbital elements. This representation is not perfect, and we may conclude that the actual orbit is not a parabola, but instead either a highly elongated ellipse or a weak hyperbola. However, the relatively short arc of the orbit that had been covered by observation is almost indistinguishable from a part of a parabola.

Later positional observations have been secured at many observatories, and will allow more refined orbit calculations that will settle this question. Only then will it be possible to say anything about the period of the comet, if its orbit is in fact elliptical (closed).

In the perspective diagram on this page, showing the orbits of Comet Mrkos and the earth, the following facts may be seen from the relative positions of these two bodies. In July, before the comet was discovered, it lay so nearly in line with the sun that it remained undetected. The initial discoveries, during the interval July 29-August 2, were made when the comet was west of the sun, and hence in the morning sky. The rapid eastward motion carried the comet under the north celestial pole into the evening sky by the second week of August. Later, as the distance of the comet from both the earth and sun increased, the object remained in the evening sky, fading as it moved southwestward. By November, it will be nearly in line with and beyond the sun. The track of the comet among the stars since discovery is seen in the chart above.



The relation of the orbits of Comet Mrkos and the earth is shown here, with comet positions for every tenth day. The line of nodes is the intersection of the nearly perpendicular orbital planes.

At Munich, West Germany, Karl Brandl took this 20-second exposure of Comet Mrkos on August 14th at 20:15 UT, using a 35-mm. camera with an f/2 Heligon lens and Ilford HPS film.

Listed here are predicted right ascensions and declinations of Comet Mrkos (1957 co-ordinates) for 0^h Universal time of every fifth day. The quantities Δ and r are the distances in astronomical units of the comet from the earth and sun, respectively. The magnitudes have been predicted from the empirical formula

$$m = 6.0 + 10 \log r + 5 \log \Delta,$$

but according to L. E. Cunningham, Leuschner Observatory, the comet during early September was about one magnitude brighter than as given by the formula.

1957	*R.A.*	*Dec.*	Δ	*r*	*Mag.*
Sept. 24	14^h 43^m.8	+0° 16′	1.891	1.300	8.5
Sept. 29	14 54.9	−2 13	2.025	1.390	9.0
Oct. 4	15 04.9	−4 25	2.158	1.478	9.4
Oct. 9	15 14.2	−6 20	2.288	1.565	9.7
Oct. 14	15 22.8	−8 02	2.414	1.649	10.1
Oct. 19	15 30.9	−9 34	2.537	1.732	10.4
Oct. 24	15 38.5	−10 56	2.657	1.813	10.7
Oct. 29	15 45.9	−12 11	2.774	1.893	11.0

Sky and Telescope thanks the many readers who have sent observational reports, drawings, and photographs of Comet 1957d. The following had submitted contributions up to September 4th:

T. Agos, Worcester, Mass.; C. Aikman, Newport, Vt.; I. Alexeff, Madison, Wisc.; J. Ansley, Alliance, Ohio; J. Borras, Palma de Mallorca, Spain; R. Bourne, West Hartford, Conn.; D. Bower, Knoxville, Tenn.; K. Brandl, Munich, West Germany; E. Burke, Jr., Bristol, Tenn.; J. Conklin, Mullica Hill, N. J.; S. Cooke, Minneapolis, Minn.; G. Doschek, Pittsburgh, Pa.; A. Eastman, Rockford, Ill.

J. Farrell, Ft. Worth, Tex.; W. Feibelman, Pittsburgh, Pa.; J. Flink, Providence, R. I.; R. Franklin, Rocky Point, N. Y.; C. Frenzel, Bartlesville, Okla.; H. Giclas, Lowell Observatory, Flagstaff, Ariz.; B. Gilligan, Akron, Ohio; A. Goodacre, Victoria, B. C.; C. Griffin, Concord, Calif.; J. Haralson, Augusta, Ark.; R. Heath, Temple City, Calif.; L. Hollen, Fallentimber, Pa.; J. Hopf, Newport, R. I.; C. Hoppa, Pittsburgh, Pa.; W. Houston, Manhattan, Kans.

J. Keeth, Spokane, Wash.; R. Kelsey, Hamburg, N. Y.; F. Kennedy, Los Angeles, Calif.; V. Killick, Sacramento, Calif.; D. Kulas, Stevens Point, Wisc.; J. Kuntz, Ray, Ind.; G. Landry, San Jose, Calif.; J. Lee, Abilene, Tex.; J. Leppert, Sarles, N. D.; E. Love, Detroit, Mich.; G. Lovi, Lakewood, N. J.; R. Lynds, Leuschner Observatory, Berkeley, Calif.; D. Mann, Temple City, Calif.; A. McClure, Los Angeles, Calif.; F. Miller, University of Michigan Observatory, Ann Arbor, Mich.; S. Morris, Victoria, B. C.

G. Newsom, Candlewood Isle, Conn.; E. Nichol, Dodge City, Kans.; J. Otoupalik, Greeley, Colo.; B. Peterson, San Jose, Calif.; Miss J. Price, Alice, Tex.; P. Preo, Rochester, N. Y.; D. Reed, Cranston, R. I.; L. Robinson, Sylmar, Calif.; W. Roth, Park Forest, Ill.; D. Sapp, Gore, Ohio; C. Scarborough, Dothan, Ala.; J. Senne, Ames, Iowa; K. Shuda, Stevens Point, Wisc.; G. Trotzuk, Detroit, Mich.; K. Wayland, Henderson, Tex.; W. Webster, Jr., Islip Terrace, N. Y.; C. Whitcomb, Jr., San Diego, Calif.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

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MOON PHASES AND DISTANCE

Full moon	October	8, 21:42
Last quarter	October	16, 13:44
New moon	October	23, 4:43
First quarter	October	30, 10:48
Full moon	November	7, 14:32

	October	Distance	Diameter
Apogee	5, 22h	252,300 mi.	29′ 26″
Perigee	21, 13h	224,400 mi.	33′ 5″
	November		
Apogee	2, 12h	251,700 mi.	29′ 30″

VARIABLE STAR MAXIMA

October 4, R. Sculptoris, 012233, 5.8; 6, RU Sagittarii, 195142, 7.2; 10, T Cephei, 210868, 5.8; 20, S Carinae, 100661, 5.7; 21, R Reticuli, 043263, 7.7; 26, X Ophiuchi, 183308, 6.9; 30, V Cancri, 081617, 8.0.

November 2, RS Herculis, 171723, 8.0; 2, T Normae, 153654, 7.4; 3, Omicron Ceti (Mira), 021403, 3.7; 4, R Normae, 152849, 7.2; 6, R Indi, 222867, 8.0.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

MINIMA OF ALGOL

October 1, 21:08; 4, 17:57; 7, 14:46; 10, 11:35; 13, 8:23; 16, 5:12; 19, 2:01; 21, 22:49; 24, 19:38; 27, 16:27; 30, 13:16. November 2, 10:05; 5, 6:53; 8, 3:42; 11, 0:31.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Pallas, 2, 7.8. October 9, 3:02.3 −17-54; 19, 2:56.9 −20-53; 29, 2:49.6 −23-30. November 8, 2:41.4 −25-32; 18, 2:33.3 −26-53; 28, 2:26.3 −27-30.

Massalia, 20, 8.5. October 19, 3:39.8 +19-13; 29, 3:33.2 +18-45. November 8, 3:24.2 +18-08; 18, 3:14.2 +17-26; 28, 3:04.6 +16-44. December 8, 2:56.9 +16-09.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

OCTOBER METEORS

The moon will be so close to new that its light will not hamper observations of the Orionid shower this year. Peak activity will occur on the morning of October 21st, when a maximum rate of 20 meteors per hour is predicted. The swiftly moving Orionids are best observed after midnight, when the radiant is highest in the sky; it is at right ascension 6h 20m, declination +15°, about 10 degrees northeast of Betelgeuse. E. O.

OCCULTATION PREDICTIONS

October 6-7 **Lambda Piscium** 4.6, 23:-39.9 +1-32.6, 14. Im: **A** 8:04.4 −0.5 +0.1 47; **B** 8:04.8 −0.4 +0.5 35; **C** 8:01.8 −0.7 −0.1 58; **D** 8:01.0 −0.6 +0.4 40; **E** 7:50.0 −1.0 +0.6 45; **F** 7:37.9 −1.8 +0.1 69; **H** 7:09.1 −1.1 +2.7 21.

October 14-15 **Lambda Geminorum** 3.6, 7:15.6 +16-37.2, 22. Em: **B** 4:22.1 +0.5 +2.8 223.

October 28-29 **Rho Sagittarii** 4.0, 19:-19.2 −17-55.8, 6. Im: **A** 0:37.7 −1.3 −1.1 88; **B** 0:33.4 −1.2 −0.9 80; **C** 0:35.0 −1.6 −1.1 92; **D** 0:27.4 −1.4 −0.7 77; **E** 0:10.0 −1.8 −0.1 73; **F** 23:54.9 −2.6 −0.1 85.

October 29-30 **Beta Capricorni** 3.2, 20:-18.6 −14-55.1, 7. Im: **H** 5:27.1 −2.2 −3.8 128; **I** 4:58.7 −1.0 −1.0 77. Em: **H** 6:02.1 +0.6 +2.9 187.

October 30-31 **Nu Aquarii** 4.5, 21:07.3 −11-32.8, 8. Im: **H** 5:42.8 −1.4 −1.1 88; **I** 5:33.1 −0.7 0.0 46.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo,** lat. **L**) within 200 or 300 miles of a standard station (long. **LoS,** lat. **LS**). Multiply **a** by the difference in longitude **(Lo − LoS),** and multiply **b** by the difference in latitude **(L − LS),** with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.3	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.6,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

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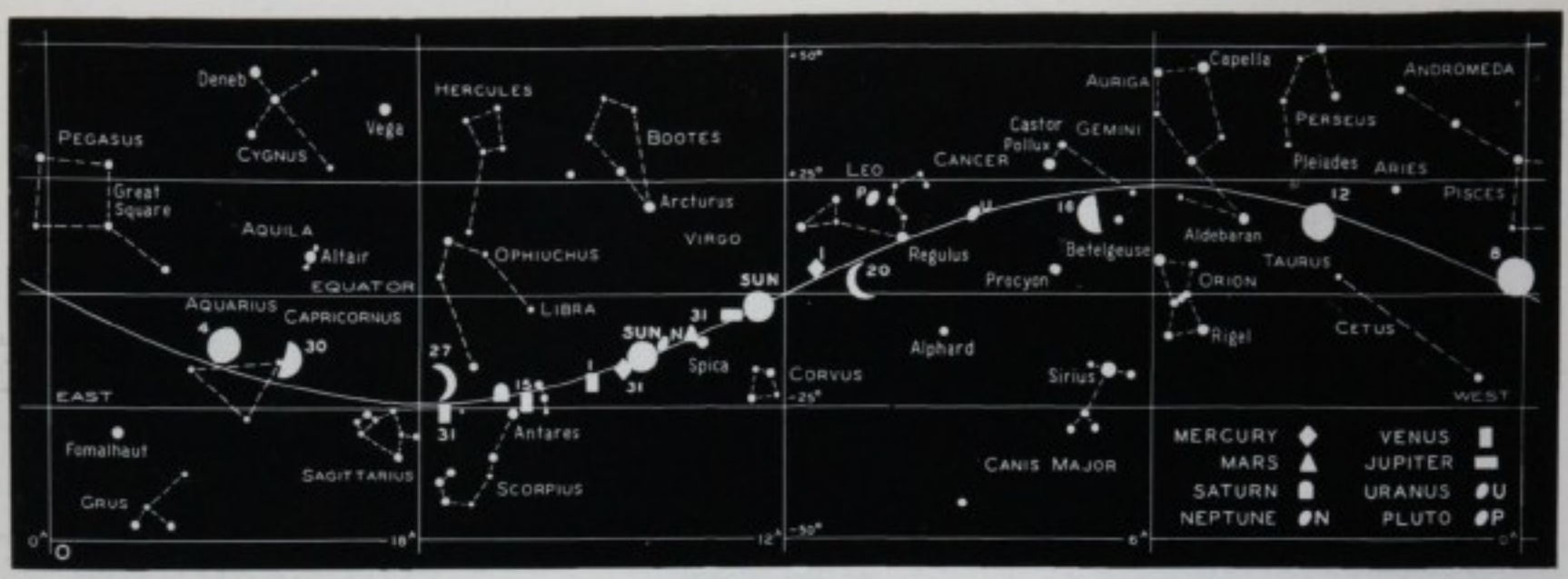

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0h Universal time on the respective dates.

The sun will be eclipsed in the Antarctic on October 23rd, totality being visible only for a small area of the Weddell Sea. The event will be of special interest to ionospheric observers on IGY expeditions, as described on page 581.

Mercury may be viewed in the morning sky during the first week of October, when it rises one hour before the sun and is of magnitude −0.9. Superior conjunction with the sun occurs on the 24th.

A difficult but unusual twilight observation may be possible for two or three mornings beginning October 13th, using binoculars or more powerful optical aid. The stars of western Virgo, including 3rd-magnitude Gamma Virginis, will rise ahead of Mercury. As the planet comes up, only 40 minutes ahead of the sun and just above the brightest glow on the horizon, Jupiter and Mars may be seen to Mercury's right (southward). By the 16th, Mercury will have passed the other two, and Mars will be the first to rise. During this series of conjunctions, the three planets will be within 2° of each other. Their approximate magnitudes will be: Mercury −1.0, Jupiter −1.2, and Mars +2.1.

Venus continues to draw away from the sun in the evening sky, since greatest elongation will occur on November 18th. The planet is gradually brightening, being of magnitude −3.7 on the 15th. Venus then will have a telescopic disk 18.2 seconds of arc in diameter, 65-per-cent illuminated.

Mars, now a 2nd-magnitude object in Virgo, may be seen without optical aid at the end of October, rising about one hour before the sun.

Jupiter passes conjunction with the sun on the 5th, entering the morning sky. It may be detected telescopically about 10 days later, in conjunction with Mercury and Mars as described above, and should be visible to the unaided eye about October 21st.

Saturn can be viewed low in the southwestern evening sky, setting some 2½ hours after the sun. On the 20th, faster-moving Venus passes 4° 07′ south of Saturn. The ringed planet is currently at magnitude +0.8, as it moves slowly eastward in Ophiuchus. Its moon Titan is at eastern elongation on the 7th.

Uranus rises about four hours before the sun on October 15th. This 6th-magnitude object is about 4° east of Delta Cancri, in very slow eatsward motion.

Neptune is too near the sun in the sky to be observed, conjunction occurring on October 26th. —E. O.

SUNSPOT NUMBERS

July 1, 187; **2,** 204; **3,** 208; **4,** 269; **5,** 216; **6,** 257; **7,** 194; **8,** 147; **9,** 167; **10,** 135; **11,** 110; **12,** 96; **13,** 96; **14,** 140; **15,** 169; **16,** 200; **17,** 210; **18,** 218; **19,** 225; **20,** 244; **21,** 250; **22,** 290; **23,** 285; **24,** 272; **25,** 232; **26,** 206; **27,** 173; **28,** 158; **29,** 142; **30,** 171; **31,** 152. Mean for July: 194.3.

These are observed mean relative sunspot numbers from Zurich Observatory and its stations in Locarno and Arosa.

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4" REFRACTING TELESCOPE
240-POWER

Complete with Finder, Equatorial Mounting, Tripod, Eyepiece Extension, Star Diagonal, and Three Eyepieces

Our newest development. Built for rugged use, quality performance. Mounting made from heavy iron castings with machined bearings for smooth operation. Tripod has extra-heavy 60" hardwood legs. Telescope's weight is 42 lbs., giving stable, steady viewing. Big 4" objective is an air-spaced achromat, each element coated on both sides for low reflection. Three eyepieces supplied give you 48X, 120X, and 240X. Special Barlow lens also gives up to 500X. Star diagonal included for comfortable viewing at high angles. Rack-and-pinion focusing. All metal parts are plated to prevent rusting. Finder is 8 power. The usual price for a 4" refractor of comparable quality is over $400, so our new model saves you almost 40%.

Stock #85,038-Y.....**$247.00** f.o.b.
(Shipping wt. 55 lbs.) Barrington, N. J.

SILICONE POLISHING AND CLEANING CLOTHS

Modern research produced this amazing new product. These cloths combine the miracle of silicones with a nonwoven, all-rayon cloth. Washable (use over and over)—they will dust, polish, and protect mirrors, reflectors, lenses, coated optics, crystal glass, plexiglass, lucite, and many other plastics. Vastly superior to diaper rags, cheesecloth, lens tissue. These are the only cloths that will not scratch any polished or smooth surface. They are lintless, nonoily, and nongreasy. Antifogging of glass is another benefit from their use. Cloths are 18" x 16".

Stock #60,059-Y.....**Package of 3 cloths $1.00 ppd.**
Stock #70,137-Y.....**Package of 100 cloths $26.50 ppd.**

Lower prices on larger quantities

ROTATING STAR CHART

Planisphere with a rotating chart shows well over 500 stars in the heavens and their relationships to each other at any selected day and hour. Table on reverse side supplies valuable information on constellations, navigation stars, locations of the planets according to month and year, dates of meteor showers, the zodiac, and the like.

Stock #9227-Y.....**$.50 ppd.**

WAR-SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3. 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for most types of telescopes. Gov't. cost $26.50.

Stock #5223-Y.....**$7.95 ppd.**

EDSCORP SATELLITE TELESCOPE

OPTICS: The Satellite Scope has two important optical characteristics: A wide (51-mm.) diameter, low-reflection-coated objective lens. A six-element extremely wide-field, coated Erfle eyepiece that, in combination with the objective, gives 5.5 power with a big 12° field and over 7-mm. exit pupil.

OTHER USES FOR THE SATELLITE SCOPE

1. Makes a perfect wide-field finder. A special groove on the barrel helps in locating it in the finder mount. Fits our twin-ring finder mount, Stock No. 70,079-Y—$9.95. 2. Use the Erfle eyepiece on your regular astronomical telescope. You will need our adapter, Stock No. 30,171-Y — $3.95, which gives you an O.D. of 1¼". This eyepiece cost the government $56.00! 3. Makes a wonderful comet seeker; see complete asterisms. 4. Makes a fine rich-field telescope; see wide areas of sky with deep penetration.

Especially Made for Members of MOONWATCH

Stock #70,074-Y.....**$49.50 ppd.**

THE METZGER GLARE-REDUCTION SCREEN

The Metzger Glare-Reduction Screen is an accessory to refractors and reflectors, designed to cut planetary glare and help in observing finer planetary detail. This seemingly simple diffraction screen is a modern-type opeical stop that sharpens the image without as much light loss as the old traditional circular stop. It has been most successful on the planet Mars, but is equally satisfactory on Jupiter, Saturn, Venus, and other planets. It was not designed especially for lunar observations because of the immense amount of light from the moon.

Much time and testing has been expended experimenting with finer and coarse screens to determine the most satisfactory. This mesh is the optimum. Obviously with the use of any diffraction screen, you will observe rays around any bright object in the field, but the object being observed will itself be in a darkened area. Since scattered light from a bright planet helps reduce contrast, the Glare-Reduction Screen improves contrast. The screen also helps when seeing conditions are not the best.

Before being placed on the market, the Glare-Reduction Screen was field-tested over a long period and is now being used by many amateur astronomers who have attested its value for critical observational work.

The kraft-paper mount affords ample protection to the screen, which should be flat and should not be kinked, dented, or wavy. The screen does not have to fit snugly over the telescope tube but, if the fit is too loose, build up the mount with additional cardboard or corrugated packing. The Glare-Reduction Screen on 6" telescopes should center on the optical axis, which will align the cut-out hole.

Stock # 70,138-Y—for 5" O.D. tubes.....**$2.95 ppd.**
Stock # 70,139-Y—for 7" O.D. tubes.....**$3.95 ppd.**

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,038-Y	4⅞"	5¼"	46"	Spiral-wound paper	$2.50
85,008-Y	6⅞"	7⅜"	60"		4.00
85,011-Y	2⅞"	3"	48"	Aluminum	6.00
85,012-Y	3⅞"	4"	60"		8.75
85,013-Y	4⅞"	5"	48"		9.00
85,014-Y	6⅞"	7"	60"		15.00

All tubing is shipped f.o.b. Barrington, N. J.

EDMUND SCIENTIFIC CO.

WAR-SURPLUS KELLNER EYEPIECE

Mounted — Ready to Use — 1¼" Outside Diameter — Coated — 1¼" Focal Length

Consists of an achromatic eye lens and an achromatic doublet field lens (Gov't. cost about $30). The clear aperture of the lenses is approximately 1", giving wide exit pupil and a clear image. Excellent for any telescope when low power and a wide field are needed. Try it for 10 days — if you don't agree that the performance is better than any commercial type selling for two or three times our price, we will refund your money in full.

Stock #50,130-Y.....$5.90 ppd.

Rack & Pinion Eyepiece Mounts

For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅜" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder)	**$9.95 ppd.**
Stock #60,035-Y (diagonal holder only)	**1.00 ppd.**
Stock #50,103-Y (for 2⅞" I.D. tubing)	**12.95 ppd.**
Stock #50,108-Y (for 3⅜" I.D. tubing)	**13.95 ppd.**

HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

HUYGENS TYPE — STANDARD 1¼" DIAMETER
6-mm. (¼") Focal Length
Stock #30,063-Y ..... $8.50 ppd.

12.5-mm. (½") Focal Length
Stock #30,064-Y ..... $8.00 ppd.

COMBINATION EYEPIECE — 10-mm. and 20-mm.
Stock #30,065-Y ..... $9.00 ppd.

7X FINDER TELESCOPE—ACHROMATIC

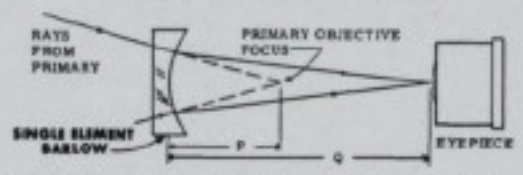
Stock #50,080-Y Finder alone, less ring mounts $9.95
Stock #50,075-Y Ring mounts per pr. $3.95

HEAVY-DUTY EQUATORIAL MOUNT AND TRIPOD for 6" - 8" REFLECTING TELESCOPE

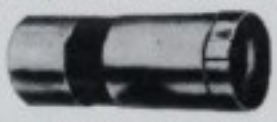
Heavy cast base with sturdy 32" long hardwood legs. 1" shafts. Boston bronze bearings to provide a uniform film of lubrication over entire bearing surface and assure smooth operation. Big locking knobs 1¾" on both declination and polar axes. Polar axis variable for latitude adjustment. 12" cradle securely holds 5" to 10" tubes. Beautifully finished in baked black wrinkle paint. Legs can be removed easily for permanent post mounting. Height 38", weight 32 lbs.

Stock #85,023-Y.....$49.50 f.o.b.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!



Beautiful chrome mount. We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of −1-5/16". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

Stock #30,200-Y Mounted Barlow lens .... $8.00 ppd.

ATTENTION — BEGINNERS AND JUNIOR ASTRONOMY CLUBS

To solve the problem of low-cost lenses of good quality for a beginner's telescope we have had these achromatic lenses designed and mass produced. They are swell!

ACHROMATIC OBJECTIVE, 32-mm. diameter (1¼"), F. L. 31". (Will get 31X with 1" eyepiece; 62x with ½" eyepiece.)
Stock #30,201-Y ..... $2.50 ppd

ACHROMATIC OBJECTIVE, 42-mm. diameter (1-21/32"), F. L. 41". (Will get 41X with 1" eyepiece; 82X with ½".)
Stock #30,202-Y ..... $4.00 ppd.

PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead with refracting telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

Stock #70,077-Y.....$12.00 ppd.

SPITZ MOONSCOPE

A precision-made 32-power reflecting telescope — by makers of Spitz Jr. Planetarium. Clearly reveals the craters of the moon, shows moons of Jupiter, other wonders of the heavens. Based on same principles as world's giant telescopes. Stands 36" high on removable legs. Adjustable 3" polished and corrected mirror. Fork-type altazimuth mount rotates on full 360° circle — swings to any location in the sky. Fascinating 18-page instruction book; sturdy carrying case.

Stock #70,068-Y.....$14.95 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces, and diagonal. No metal parts.

Stock #50,074-Y.....$16.25 ppd.

6X FINDER TELESCOPE

Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

Stock #50,121-Y.....$8.00 ppd.

MISCELLANEOUS ITEMS

KELLNER EYEPIECE — 2" focal length (1¼" O.D.). Mount of black anodized aluminum.
Stock #30,189-Y ..... $6.00 ppd.

60° SPECTROMETER PRISM — Polished surfaces 18-mm. x 30-mm. — flat to ½ wave length.
Stock #30,143-Y ..... $8.25 ppd.

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16", O.D. 1-5/16".
Stock #40,165-Y ..... $1.75 ppd.

30-day Money Back Guarantee as with all our Merchandise!

BE SURE TO GET FREE CATALOG "Y"

Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

BARRINGTON • NEW JERSEY

These and the front-cover picture show the aurora of August 5-6, photographed by W. A. Feibelman at Pittsburgh.

AURORAS IN AUGUST

AMONG a number of auroral displays that occurred in August and were reported by amateur observers, the one of August 5-6 was perhaps most striking. It was photographed at Pittsburgh, Pennsylvania, by Walter A. Feibelman, 11 pictures being taken between 4:10 and 4:52 a.m. Eastern daylight time, exposure times ranging from 15 to 60 seconds.

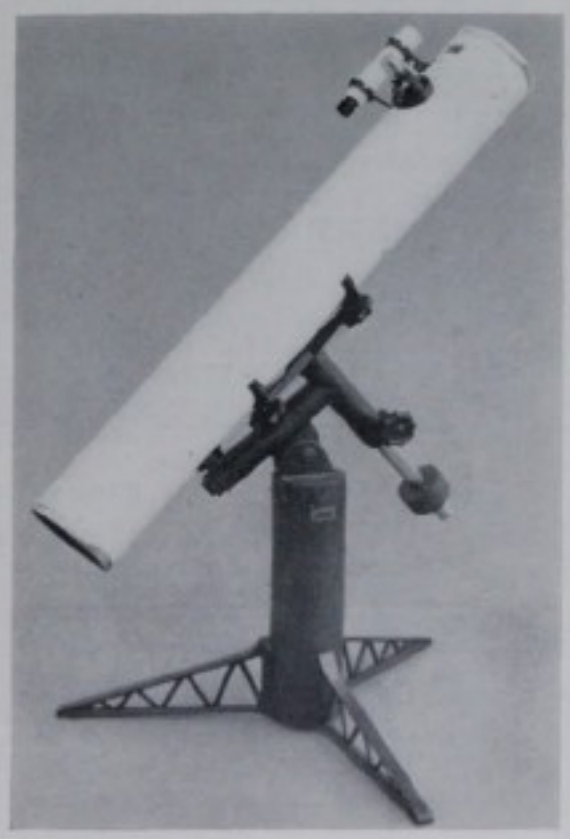
Examples of Mr. Feibelman's results are reproduced here and on the front cover, the latter being taken at 4:25 a.m., just one minute before the picture at the left above. Some significant changes in the aurora occurred in that interval. The picture at the right, taken 26 minutes later, is the last of the series, because the light of dawn began to interfere.

Although bright draperies appeared and most of the streamers reached as high as Polaris, the general aspect of this aurora was much quieter than that of July 1st (see page 555, September issue), according to Mr. Feibelman.

He also photographed the northern lights on August 12-13, despite the light of a moon only two days past full. This same display, consisting of rayed arcs, was seen at Creston, Ohio, by Roger Grossenbacher and Donald Goembel, beginning about 11:45 p.m. Eastern daylight time.

The Ohio amateurs were principally engaged in observing the Perseid meteor shower, logging 55 meteors in all between 9:40 p.m. and 1:15 a.m. One slow, reddish fireball of magnitude −2, which passed from Deneb to Schedir, seemed near the end of its flight to grow in size; it then broke up into five fragments, which continued in forward motion before vanishing.

ASTROLA Reflecting Telescopes



Standard Model "A" 6-inch ASTROLA, f/8, complete with 3 oculars (72x, 180x, 315x) **$295.00**

AMERICAN MADE

STANDARD MODEL "A",	6-inch	**$295.00**
STANDARD MODEL "B",	8-inch	**$375.00**
STANDARD MODEL "C",	10-inch	**$475.00**

These instruments are fully portable—as they can be assembled or taken down in three minutes. Each comes with three of the finest oculars. The equatorial head and stand are of cast aluminum. The fiberglass tube is made by W. R. Parks. Optics are corrected to ⅛ wave or better and are quartz coated. ASTROLAS will resolve double stars to the Dawes limit. Clock drives, rotating tubes, setting circles furnished at additional cost.

ARE YOU SATISFIED WITH YOUR PRESENT MIRROR?

If your mirror does not give the fine performance you need for satisfactory observing, the expert opticians at Cave Optical Co. will refigure it at a reasonable price, or offer you a new precision-ground pyrex mirror. Whichever you choose, your mirror will have a fine figure, good to ⅛ wave length or better.

REFIGURING MIRRORS

Refiguring, aluminizing, and quartz coating your mirror. Diagonal also provided.

6-inch	**$35.00**
8-inch	**$50.00**
10-inch	**$75.00**
12½-inch	**$120.00**

PYREX MIRRORS

New pyrex mirrors, aluminized and coated. Diagonal also provided.

6-inch	**$60.00**
8-inch	**$92.50**
10-inch	**$160.00**
12½-inch	**$250.00**

All prices f.o.b. our plant, Long Beach, Calif., and subject to change without notice. Send for catalogue.

CAVE OPTICAL COMPANY

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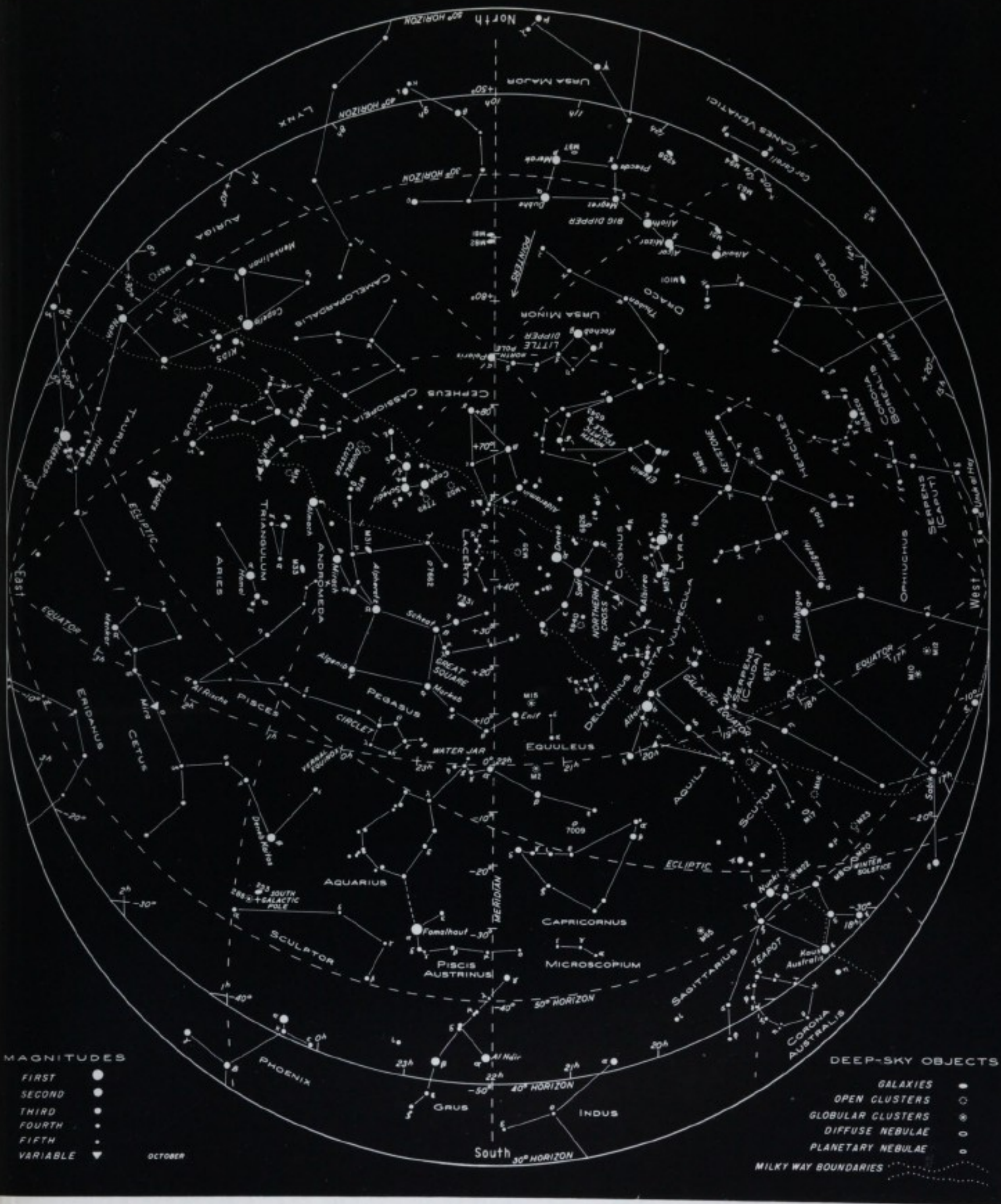

STARS FOR OCTOBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of October, respectively; also at 7 p.m. and 6 p.m. on November 7th and 23rd. For other dates, add or subtract ½ hour per week.

High up the southern sky during the crisp evenings of autumn is the Great Square in Pegasus, an easily recognized sky landmark. Inside this square Norton's "Star Atlas" shows 32 stars visible to the naked eye. How many can you count on a clear, moonless night?

Why the 4-inch DYNASCOPE Reflector

Reg. U.S. Pat. Off.

is now used and approved by over 40 colleges and professional institutions

A Complete, Superior Telescope with Advanced Features

Compare These Advances:

1) 4-INCH PARABOLIC PYREX MIRROR — aluminized and overlaid with zircon quartz for maximum life!
2) 3 ACHROMATIC EYEPIECES — 18-mm. Huygens, 9-mm. Ramsden, 7-mm. Ramsden—providing 65X, 130X and 167X!
3) RACK & PINION focusing!
4) 4-POWER Achromatic FINDER SCOPE!
5) NEW IMPROVED MOUNT—fine equatorial with free moving polar axis.
6) SIMPLE LATITUDE ADJUSTMENT—making your instrument usable anywhere in the world.
7) ALL-BAKELITE TUBE, brass-trimmed!
8) CLAMPS ON BOTH AXES—adjust instantly and permit smooth setting of either axis.
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There's an excellent reason why the 4-inch DYNASCOPE Reflector is now the instrument used, approved and recommended by more and more schools, colleges, planetariums and professional astronomers. It is the remarkable scientific accuracy and engineering balance built into this complete telescope — at an incredibly low price! If you were to purchase the parts and assemble them yourself, you would spend much more than the unheard of low price of this precision instrument. And in building your own telescope you could never hope to attain the accuracy and co-ordination of parts that have been engineered into the Dynascope.

The 4-inch parabolic mirror produces exquisite definition of all the bright planets and is fully capable of splitting close double stars. (Note: the 4-inch mirror gathers ½ more light than a 3½-inch mirror!) Finished to exacting specifications and guaranteed to perform to the Dawes' limit of resolution for its size! A 4-inch parabolic mirror of such quality has only been obtainable in the highest-priced instruments up to now!

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TESTIMONIALS:

From An Observer

On clear "good-seeing" nights my Dynascope easily reveals the Alpine Valley and the Straight Wall on the Moon, as well as three peaks in the floor of the Plato ring plain. It will split the star Mizar into its major components clearly. It will separate Saturn's rings and show six bands on the face of Jupiter. Also it will project a two-foot diameter disk of the sun showing sunspots in vivid detail . . . as an Englishman might express it, "Dynascope optics are a little bit of all right." —VICTOR W. KILLICK, in charge of Astronomical Observatory, Sacramento Junior College, Calif.

Many Years of Experience

. . . I have had many years of experience in astronomy, and as junior leader here in Atlanta I always recommend Dynascope. —LEONARD B. ABBEY, Jr., Decatur, Ga.

Cannot Be Equaled

I still don't see how you can produce a parabolic mirror of this focal ratio at the price . . . Epsilon Lyra was quite easy . . . on the 130 power ocular. I was more than pleased when it resolved this double double as four tiny, sharp, brilliant gems . . . with the diffraction rings concentric and sharp.
. . . For the price you ask, I do not believe that it can be equaled in any way. The oculars are excellent, and the entire instrument shows careful workmanship. How you do it is beyond me. —G. N. JOHNSTONE, Albuquerque, N.M.

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331 Church Street, Hartford 1, Conn.

Gentlemen:

☐ Enclosed find payment of $49.95. Please ship me promptly, subject to your money back guarantee, 4-inch DYNASCOPE Telescope with 9 advanced features.

☐ Send me FREE Illustrated Literature on the 4-inch DYNASCOPE Telescope.

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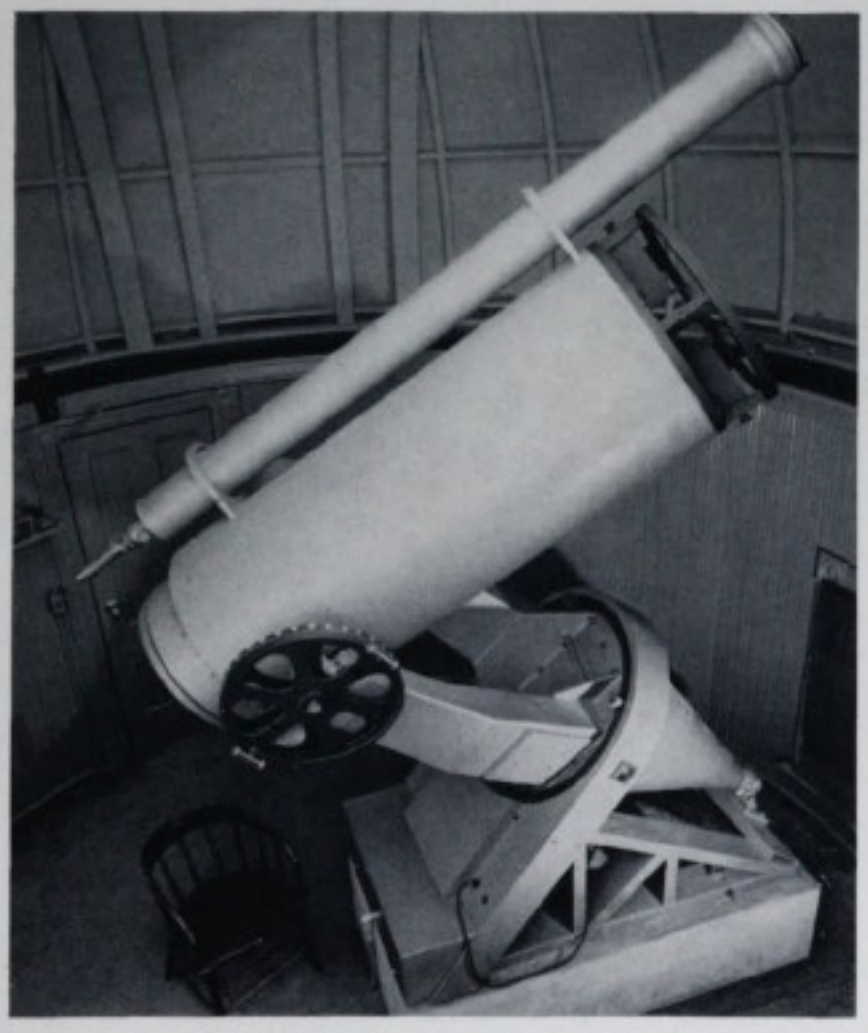
EXPERTS IN DOMES AND TELESCOPES

ASTRO-DOME, expert in the construction of observatory domes, is pleased to announce the completion of an Astro-Observatory for the Reed telescope at Yale University, New Haven, Connecticut. This building is 16 feet 6 inches in diameter and weighs 13,000 pounds. The dome is fabricated from heavy structural steel members and is covered with 16-gauge galvanized-steel sheets. The result is a dome offering smooth appearance plus great strength. The Astro-Observatory illustrated here may be obtained in diameters up to 50 feet. May we assist you with your installation?



TINSLEY LABORATORIES, expert in the production of precision instruments, thoroughly tests every optical system for absolute conformance to the highest specifications. All optical surfaces are polished to 1/10-wave accuracy, and each system is guaranteed to reach theoretical limits of resolution. Through research, development, and construction of optical devices for the United States government and industrial organizations, Tinsley Laboratories is able to furnish your telescope at lower cost without sacrifice in quality. Small and large telescopes of any design are available to the required precision. You are invited to request information of any kind that would be useful to you.

As experts in domes and telescopes, Astro-Dome and Tinsley Laboratories now make possible a complete observatory from telescope to housing at a cost that will be pleasantly reasonable. Write either company for details, which will be furnished without obligation.

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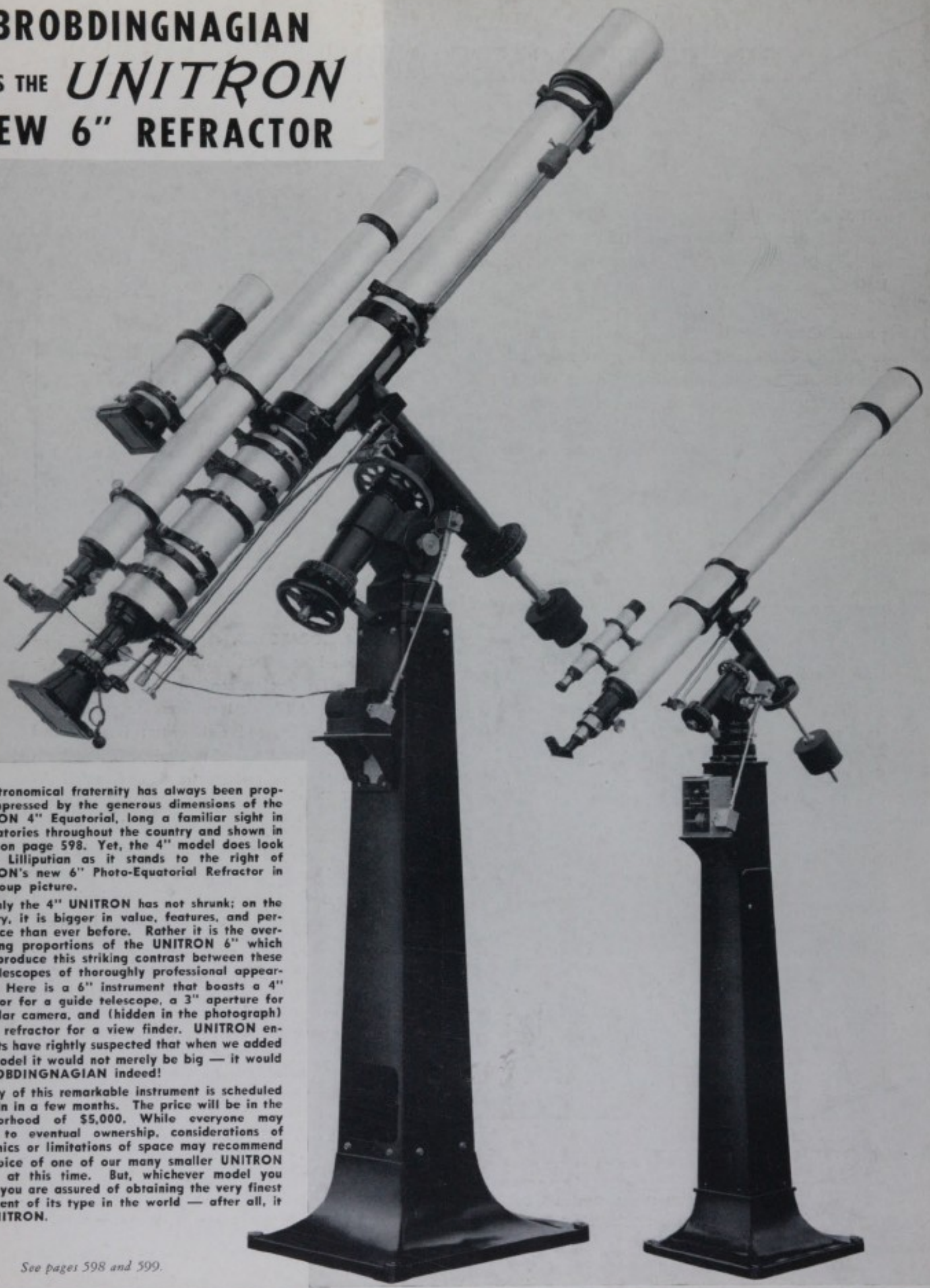
BROBDINGNAGIAN IS THE *UNITRON* NEW 6" REFRACTOR



The astronomical fraternity has always been properly impressed by the generous dimensions of the **UNITRON** 4" Equatorial, long a familiar sight in observatories throughout the country and shown in detail on page 598. Yet, the 4" model does look almost Lilliputian as it stands to the right of **UNITRON**'s new 6" Photo-Equatorial Refractor in this group picture.

Certainly the 4" **UNITRON** has not shrunk; on the contrary, it is bigger in value, features, and performance than ever before. Rather it is the overwhelming proportions of the **UNITRON** 6" which alone produce this striking contrast between these two telescopes of thoroughly professional appearance. Here is a 6" instrument that boasts a 4" refractor for a guide telescope, a 3" aperture for its stellar camera, and (hidden in the photograph) a 2.4" refractor for a view finder. **UNITRON** enthusiasts have rightly suspected that when we added a 6" model it would not merely be big — it would be **BROBDINGNAGIAN** indeed!

Delivery of this remarkable instrument is scheduled to begin in a few months. The price will be in the neighborhood of $5,000. While everyone may aspire to eventual ownership, considerations of economics or limitations of space may recommend the choice of one of our many smaller **UNITRON** models at this time. But, whichever model you select, you are assured of obtaining the very finest instrument of its type in the world — after all, it is a **UNITRON**.

See pages 598 and 599.

UNITRON

INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
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